AIR FORCE LEGENDS NUMBER 210

Republic XF-91

THUNDERCEPTOR

ROCKET FIGHTER

BY STEVE PACE

ABOUT THE AUTHOR:

A veteran writer, Steve Pace has written 20 books and 20 feature magazine articles dealing with a wide variety of aircraft and related subjects. These included attack, bomber, cargo, experimental, fighter, fighter-bomber, fighter-interceptor, foreign, patrol, prototype, research and service test types. Mr. Pace resides in Tacoma, Washington.

AUTHOR'S NOTE:

In the text, the reader will discover a number of MX numbers, which in the 1940s, 1950s, and 1960s were associated with a large number of U. S. Army Air Corps cum U. S. Army Air Forces cum U. S. Air Force (USAAC / USAAF / USAF), Air Material Command cum Air Research and development Command (AMC / ARDC) projects, which included everything from aircraft and missile projects to electronics and propulsion systems. This numbering system ultimately reached into the 3340s before the usage of MX numbers was terminated.

The designation MX-1 was used for the proposed but never built Bell XP-52 interceptor. Just a few years later when Bell was authorized to build its XP-59A Airacomet (Americas first jet airplane, see Air Force Legends Number 208), these AMC project numbers had already reached MX-397.

When Republic was awarded its contract in Fiscal Year 1946 to build two XP-91 airplanes, this numbering system had reached MX-808, which referred to an unbuilt version of the XP-91, projected to be powered by a single General Electric J35 turbojet and a Curtiss Wright rocket motor that never materialized.

When the actual XP-91 (by then XF-91) emerged in the spring of 1949, powered by a single J47 turbojet engine and later a single Reaction Motor, it carried project number MX-909. The "P' for Pursuit prefix was changed to "F" for fighter in June 1948.

CONTRIBUTORS:

Cradle of Aviation Museum; Dr. Raymond L. Puffer, Archivist / Historian, AFFTC/HO; William Swisher, and Nick Williams.

SPECIAL ACKNOWLEDGMENT:

This reference would have been impossible to produce without the professional assistance of Mr. Lynn McDonald, volunteer archivist at the Cradle of Aviation Museum, Mitchell Field, Garden City, New York.

ADDITIONAL RESEARCH:

Dr. Gary L. Rochfort, *The Republic XF-91: Short-lived Thunder in the Sky*, Journal of the American Historical Society, Spring 1989; Philip Jarrett, *Thundercepter*, Aeroplane Monthly, April 1985; and Terry L. Sunday, *Thunderceptor*, Airpower, September 1986.

NEWS RELEASE:

Republic Aviation Corporation, Public Relations Department, for A.M. Release Wednesday, May 11, 1949.

NEW AIR FORCE INTERCEPTOR MAKES FIRST FLIGHT: REPUBLIC XF-91 IS TEST FLOWN AT MUROC AIR FORCE BASE.

The first flight of a new U. S. Air Force high-speed and high-altitude interceptor fighter, the XF-91, was made successfully on May 9, 1949 at Muroc Air Force Base, California. Carl A Bellinger, RAC's chief experimental test pilot, flew the airplane, the first of two experimental models designed and built by Republic Aviation Corporation (RAC).

A 5,000-pound thrust General Electric J47 turbojet engine supplied power for the initial flight of the XF-91. The plane is also designed to utilize a rocket motor for accelerated takeoff and climb and for operation at high altitudes, but the rocket motor -- in development, will not be used until later flight-test evaluations are undertaken.

FRONT COVER:

The second XF-91 with a "V" or "Butterfly" tail being tested, prior to having the radar nose fitted and the single vertical fin fitted as on the first XF-91. (Cradle of Aviation Museum)

The main landing gear wheels are arranged in tandem, the two wheels under each wing placed one ahead of the other instead of in parallel position. The main wheels retract outward toward the wing tips rather than inward toward the wing roots.

No speed or other performance figures for the XF-91 have yet been revealed.

Republic's vice president in charge of engineering, Alexander Kartveli, is credited with the design of the XF-91, assisted by R. G. Bowman, W. O'Donnell and C. E. Pappas. Project engineer for the U. S. Air Force Air Material Command is Werner Rankin. Company project engineer is Edwin Eddy and D. K. Tasker directs the flight test program a Muroc.

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BACK COVER:

Good view of the unique wing shape of the XF-91 series as seen on the first aircraft. (Cradle of Aviation Museum)

THE REPUBLIC XF-91 THUNDERCEPTER BY STEVE PACE

Above, the original XP-91 mockup, circa 1947, featuring the V-tail arrangement, which was not at first incorporated on either XP-91-cum-XF-91 aircraft. The mockup also shows the uncovered upper nose section and left-hand fuselage gun bays. Also noteworthy is the open canopy, which raised up and slid aft, the open speed brake of a type that was never used, and the main landing gear featuring side-by-side rather than tandem wheels. (Republic via Cradle of Aviation Museum)

BACKGROUND

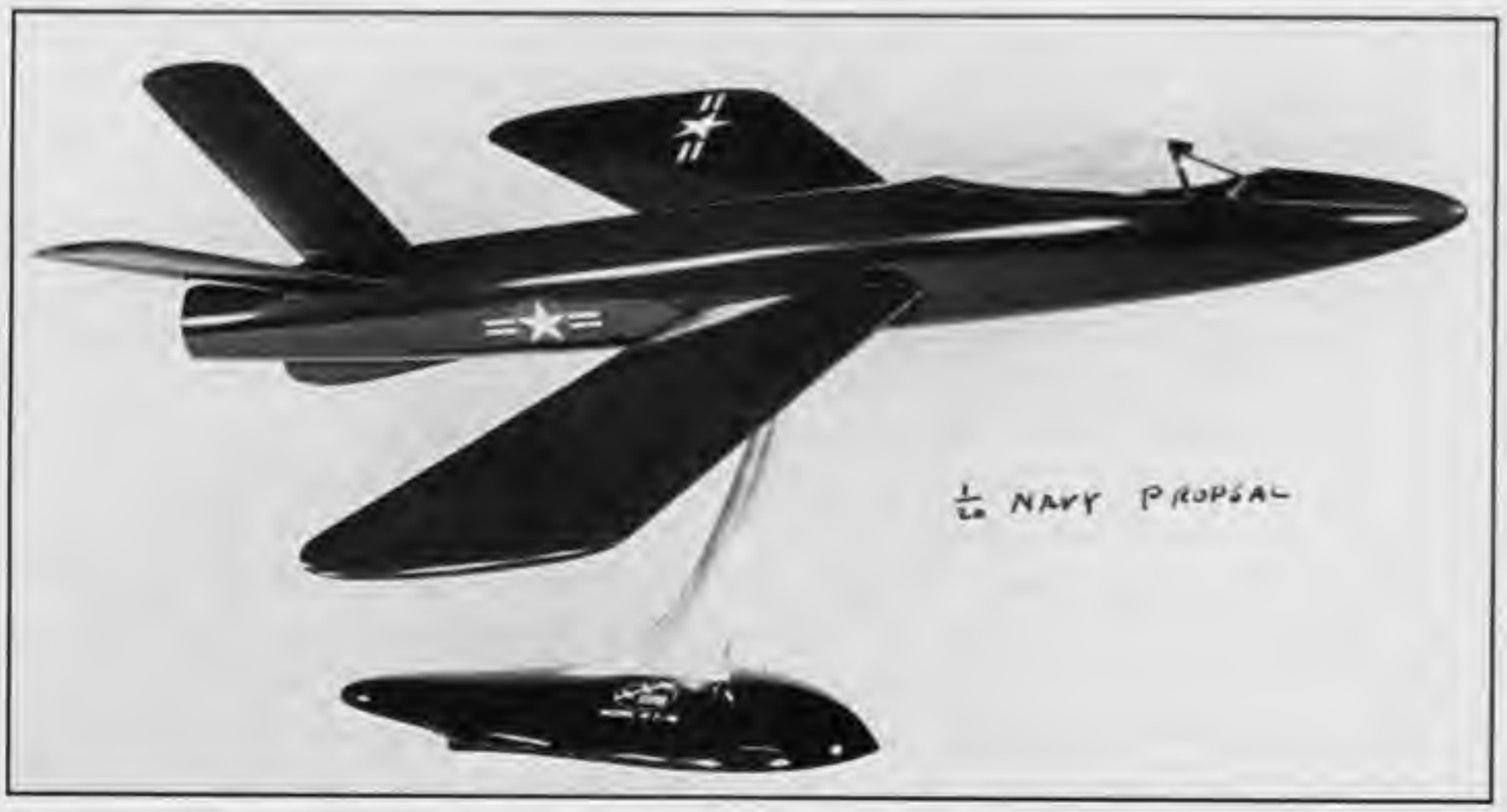
Shortly after VJ-Day and the end of World War II, the USAAF Air Material Command closed its ledger books on a number of its combat aircraft programs. Yet, due to the overriding importance of some of these programs, several of them survived those mass cutbacks.

One of the then-current and most promising of these surviving combat aircraft programs was known as Secret Project Number MX-809 (MX meaning Materiel, Experimental). The MX-809 project was created in hope of fielding a very high speed, very high altitude daytime interceptor pursuit airplane capable of "meeting and defeating any strategic bomber aircraft that any potential adversary might produce." In other words, it was to be used for the sole purpose of defending U.S. airspace.

The USAAF/AMC had therefore sent out an Invitation to Bid (ITB) to the industry in December 1945, just three months after VJ-Day. With the ITB came a Specific Operational Requirement (SOR) for the proposed interceptor pursuit. Among other things the SOR included that the airplane be capable of 25.5 minutes of combat operation in a number of steps: 2.5 min time-to-climb to an altitude of 47,500 feet (a climb rate of 19,000 feet per minute); 15 min of cruise time duration at 486 knots indicated air speed (kias); three minutes of combat duration at an average speed of 688 kias; and five minutes of descent time from 47,500 ft to landing.

With this more than challenging SOR in hand, essentially calling for an all-out performance aircraft, bidding airframe contractors opted to employ a composite propulsive system comprised of both turbojet engine(s) and rocket motor(s). To a contractor they decided that since the airborne loiter time of the projected aircraft was not a critical parameter that their designs should be propelled in just such a fashion. For each contractor knew very well that neither existing nor upcoming turbojet engines would provide the required power to propel the proposed aircraft to a maximum speed of 688 kias, which would be supersonic. Remember, it was not until some 22 months later that the speed of sound was first broken by Chuck Yeager in a Bell X-1, and that feat was accomplished by an air-launched aircraft purposely built to achieve supersonic speed and it was not powered with a turbojet engine but by a rocket motor.

Headed by the famed aeronautical engineer and aircraft designer Alexander Kartveli, the preliminary design team at Republic began to prepare its Model AP-31 (AP meaning Army Project) in early January 1946. It was a unique design that featured the use of a single, afterburning 5,200-pound thrust General Electric Model TG-180 series axial-flow J47 turbojet engine, and a single, four-chambered Curtiss-Wright XLR27-CW-1 rocket motor rated at 8,400 lb thrust (2,100 lb thrust per chamber). After many hours of engineering and preliminary design and systems



At left, two views of a 1/20th scale model showing an early configuration study for the proposed XP-91 (as it was then designated), featuring a V-tail arrangement, inverse taper wing planform and two large wing tip external fuel tanks. (Republic via Cradle of Aviation Museum)

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analysis, Republic submitted its AP-31 entry to the USAAF/AMC at Wright Field, Dayton, Ohio.

On May 29, 1946, Republic was rewarded for its AP-31 effort with a contract (W33-038-ac-14583) to produce engineering data and drawings, wind-tunnel models, a full-scale engineering mockup, a static structural loads test article and two experimental Model AP-31 prototypes of the proposed interceptor pursuit. The type was designated XP-91 and it would be used for flight-testing and combat evaluations. Respectively, they were issued USAAF serial numbers 46-680 and 46-681. These two airplanes, as it turned out, were the first swept-back-winged/tailed aircraft to be built by Republic, for as it happened, the first XP-91 would later beat the Republic YF-84F (formerly YF-96A) Thunder-streak into the air by some 13 months.

Simultaneously - in fact just a few days earlier - in Downey, California, Consolidated Vultee Aircraft (Convair) received a contract (W33-038-ac-14547) to produce three Model 7 XP-92 interceptor pursuit aircraft--USAAF serial numbers 46-682, 683 and 684, which were to compete head-to-head with Republic's XF-91 (which see later in text).

Several other airframe contractors that had vied for the high-altitude, high-speed interceptor pursuit con-

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At left, 1/20th scale is Republics Model NP-48 proposal for the US Navy. It closely resembled the XP/XF-91 but without external fuel tanks, rocket motor and, curiously, no apparent means of feeding air to its jet engine. (Republic via Cradle of Aviation Museum)

tract were eliminated from the competition.

About a year after contract award, in May 1947, the USAAF/AMC 689 Engineering Board mockup inspections were held at Republic's Long Island facility. The inspections were fruitful and the type was approved for fabrication; metal was soon cut.

The first XP-91, now designated XF-91 since the P for Pursuit prefix had become F for Fighter in June 1948, was ceremoniously rolled-out at Republic's facility on February 24, 1949.

Initially powered with just the single General Electric J47-GE-3 turbojet engine (neither the preferred version of the J47 nor the rocket motor was yet available), XF-91 number one underwent a series of low-, medium- and high-speed taxi runs at Farmingdale to thoroughly check its brakes, nose wheel steering, flaps and so on prior to flight. Republic chief test pilot Carl A. Bellinger was at the controls.

Following the taxi tests and other ground-based evaluations, the airplane was disassembled for its transportation via cargo aircraft to the Research and Development Test Center at Muroc Air Force Base (now the Air Force Flight Test Center, Edwards AFB). By 2 April 1949, the XF-91 had fully arrived at Muroc aboard two Fairchild C-82 Packets and a single Boeing C-97 Stratofreighter. After its reassembly, it was prepared for flight.

After yet another series of taxi runs in late April and early May, the airplane finally made its first flight on 9 May 1949. Because of the aircraft's excellent flying characteristics that day, Bellinger kept it airborne for a full 40 minutes instead of the planned ten to 15 min (customary for first flights in those days). He was very impressed with the Thunderceptor, as the XF-91 had now been officially named.

While Republic waited for the availability of the preferred J47 turbo-

Above, 1/32nd scale model of a proposed XP-91 design that featured the use of bifurcated (split) engine air inlet ducts and nose scoops. Below, this 1/20th scale model shows Republic's proposed Model NP-49 for the US Navy (NP meaning Navy Project). Apparently, Buck Rogers was indeed alive and well in the late 1940s. (Republic via Cradle of Aviation Museum)

Above, the premier XF-91 after its debut while it, was still at Republic's facility in New York. Below, on 24 February 1949 the first of two XF-91 airplanes was unveiled at Republic's Long Island, NY, facility to a sparse crowd of onlookers. At the time, Republic was producing F-84D Thunderjet aircraft and some of the workers were astounded to see XF-91 painted on the plane's nose rather than F-84E. Thus the sign: 'Hey! Where is the E?" (Republic via Cradle of Aviation Museum)

At right, the late, great Carl A. Bellinger posed by XF-91 number one prior to its initial taxi tests. (Republic via Cradle of Aviation Museum) Below, the XF-91's low- and medium-speed taxi tests were conducted at Republic's facility prior to the aircraft being shipped to Muroc (now Edwards) for high-speed taxi tests and flight-test operations. (Republic via Cradle of Aviation Museum)

jet engine and the Curtiss-Wright XLR27-CW-1 rocket motor, several experimental programs were undertaken.

Especially with XF-91 number two, which had arrived at Muroc in late September 1949 and had made its first flight on 14 October 1949. These included the employment of an afterburning J47-GE-17 turbojet engine (GE Model TG-190-D) rated at 7,500 lb thrust with afterburning, the installation of a V-shaped twin vertical tail assembly (called a butterfly tail), the installation of an advanced radar system, which was housed under a radome on the nose over a modified engine air inlet opening. On XF-91 number one, Republic installed a sharply pointed horizontal tail plane extension at the

THE REPUBLIC XF-91 THUNDERCEPTER WALK - AROUND (CLEAN)

At laft, head-on view of the XF-91 at Farmingdale, New York. (via Lloyd Jones) Below, 6680 at Edwards AFB on 23 January 1950 with XF-91 added to the nose. Note underbelly speed brake as used on the two XF-91s. (AFFTC/HO) Bottom, side view of the first XF-91 at Farmingdale. (via Lloyd Jones) At right, 6680 at Edwards AFB on 23 January 1950. (AFFTC/HO) At right middle, left side view. (USAF) Bottom right, 6680 at Farmingdale. (Republic via Cradle of Aviation Museum)


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U.S. AIR FORCE
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THE REPUBLIC XF-91 THUNDERCEPTER WALK - AROUND (WITH TANKS)

At left, XF-91 head-on view with its large drop tanks at Edwards AFB in 1950. (Republic via Cradle of Aviation Museum) Below, 3/4 front view illustrates unusual positioning of the large drop tanks. (Republic via Cradle of Aviation Museum) Bottom, right side view of 6680 with drop tanks installed. (Republic via Cradle of Aviation Museum) At right, 2/3 rear view of 6680. (Republic via Cradle of Aviation Museum) At right middle, family photo of F-47, XF-91 & F-84. (Republic) At right bottom, rear view with drop tanks. (Republic)


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Republic XF-91
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XF-91 FIRST FLIGHT

Above, on 9 May 1949 RAC chief test pilot Carl Bellinger successfully completed the first flight of XF-91 number one. The airplane performed so well that Bellinger kept her airborne some 30 minutes longer than had been planned. (Republic via Cradle of Aviation Museum)

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apex to improve directional control at high speeds.

Flight-testing showed conclusively that the XF-91's unprecedented inverse-taper wing planform worked and successfully reduced wing-tip stalls due to loss of lift, as Republic had advertised. The inverse taper combined with wing leading-edge slats made it possible to fly at speeds lower than were possible with contemporary jet fighters, thereby giving the XF-91 the double advantage of good performance at either low or high speed. Moreover, the extra thinness of the wing root at the fuselage junction reduced drag and permitted a more even flow of air at the fuselage-wing join area.

If placed in service, a typical intercept mission for an F-91 was to be about 25 minutes with only three minutes allotted for actual combat. With its turbojet and rocket motor units at full thrust, the Thunderceptor was to have a projected climb rate of about 40,000 fpm. The two large external tanks carried by the XF-91 held 581 gal of LOX, 397 gal of JP and 149 gal of WALC. Prior to combat these tanks would have been jettisoned. (AFFTC/HO & Republic)

XF-91 in flight over Southern California. Upper and lower views illustrate the unique inverse-taper wings that were both thinner in thickness and shorter in length at the root than they were at the tip. (Republic via Lloyd Jones and Wayne Morris)

Below, the often used public relations photo of the XF-91 on roll-out shows the wing's unusual shape. The anti-glare panel and wing-walk area on the flaps were painted olive (OD) green. (Republic via Lloyd Jones)

NUMBER TWO XF-91, SERIAL NUMBER 48-6681

Several stall (loss of lift) approaches were made during flight-testing. During the type's first flight, for example, with its wing leading-edge slats extended (lowered), the

The number two XF-91 undergoes between-flight inspection and maintenance inside a hanger at Edwards. The lower rocket motor housing doubled as a ventral fin for increased high-speed stability. (Republic via Cradle of Aviation Museum) Above right, Republic Aircraft public relations photo showing both the XF-91 and the proposed YF-96A (redesignated YF-84F) featuring wing root engine air inlets. The latter was the third of three YF-84F Thunderstreak prototypes. (Republic)


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At left, number two XF-91 (8681) in flight with modified lower rocket housing designed to accommodate four XLR-11 rocket engines. These were used in place of the still-born Curtiss-Wright XLR-27 rocket motors that were being developed for the XF-91. Although not powerful enough for the Mach 2 flight speeds envisioned for the XF-91, the XLR-11 was installed to test the XF-91's high-speed flight performance. With the aid of these engines, the XF-91 was able to fly faster than the speed of sound. (Republic) Below, XF-91 number two getting its tanks filled from a special truck that was outfitted with both a WALC and a LOX tank on its trailer. (AFFTC/HO)

At right, two views of 46-681 at Edwards awaiting a tow. (Pima Air and Space Museum and William Swisher) Bottom, 681 from above with protruding XLR-11 lower rockett housing visible. (Republic)

speed was so low that the chase plane (a North American F-86A Sabre Jet) monitoring the flight could not match the slow pace and had to fly past. Lateral control in the stall maneuver was full and positive, which was attributed to the inverse-taper quality of the wing planform.

Code named "Joe 1", the first Russian atomic bomb was successfully exploded in September 1949. That action created a panic within the U.S. Department of Defense because Russia also had the means of delivering such a weapon with its Tupolev TU-4 Bull - a near identical copy of the Boeing B-29 Superfortress, which, if flown from forward Russian

At left, 46-6681 in flight with butterfly V-tail attached. The inside and outside of the butterfly tail had U. S. Air Force and 6681 painted on them. A metal plate was applied to the rocket exhaust openings. (Republic and AFFTC/HO)

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air bases, could reach American soil. This action gave additional credence to the F-91 Thunderceptor program, but unfortunately, development of the aircraft's rocket motor was woefully behind.

Built from the outset to employ a dual propulsion system, the two XF-91 airplanes waited for their Curtiss-Wright rocket motors to arrive. Development problems, however, forced the rocket motor's cancellation. Instead, a four-chambered Reaction Motors 6,000-lb thrust (1,500 lb thrust per chamber) XLR11-RM-9 was substituted. Thus, with this change, Secret Project MX-809 became Secret Project MX-909. Still waiting for the J47-GE-17 engine, Republic tried several other versions of the J47 including the -7, -9, -13, and the aforementioned -3.

Three years of intermittent flight-testing of the two XF-91s followed - without their dual propulsion systems operable. Then, finally, the XLR11-RM-9 rocket motor arrived and it was installed in XF-91 number one in November 1952. After a closely monitored series of rocket motor firings on the ground, the airplane was at last ready to fly with its two different power plants.

With Republic test pilot Russell M. "Rusty" Roth at the controls on 9 December 1952 - 30 months after its maiden flight, the now dual-powered XF-91 number one took off and climbed to an altitude of 35,000 feet before leveling off for its speed run. Roth first lighted the J47-GE-17 afterburner to boost its thrust to maximum and then switched on the rocket motor to full thrust. The plane, already flying straight and level at more than 600 miles per hour, suddenly thundered forward and easily shot past the speed of sound, hitting 1.07 Mach number (Mn). With this action,

Republic's XF-91 is credited with the distinction of being the first non-X-type aircraft to fly faster than sound in level attitude flight. A number of additional high-speed flights followed, all of which were successful.

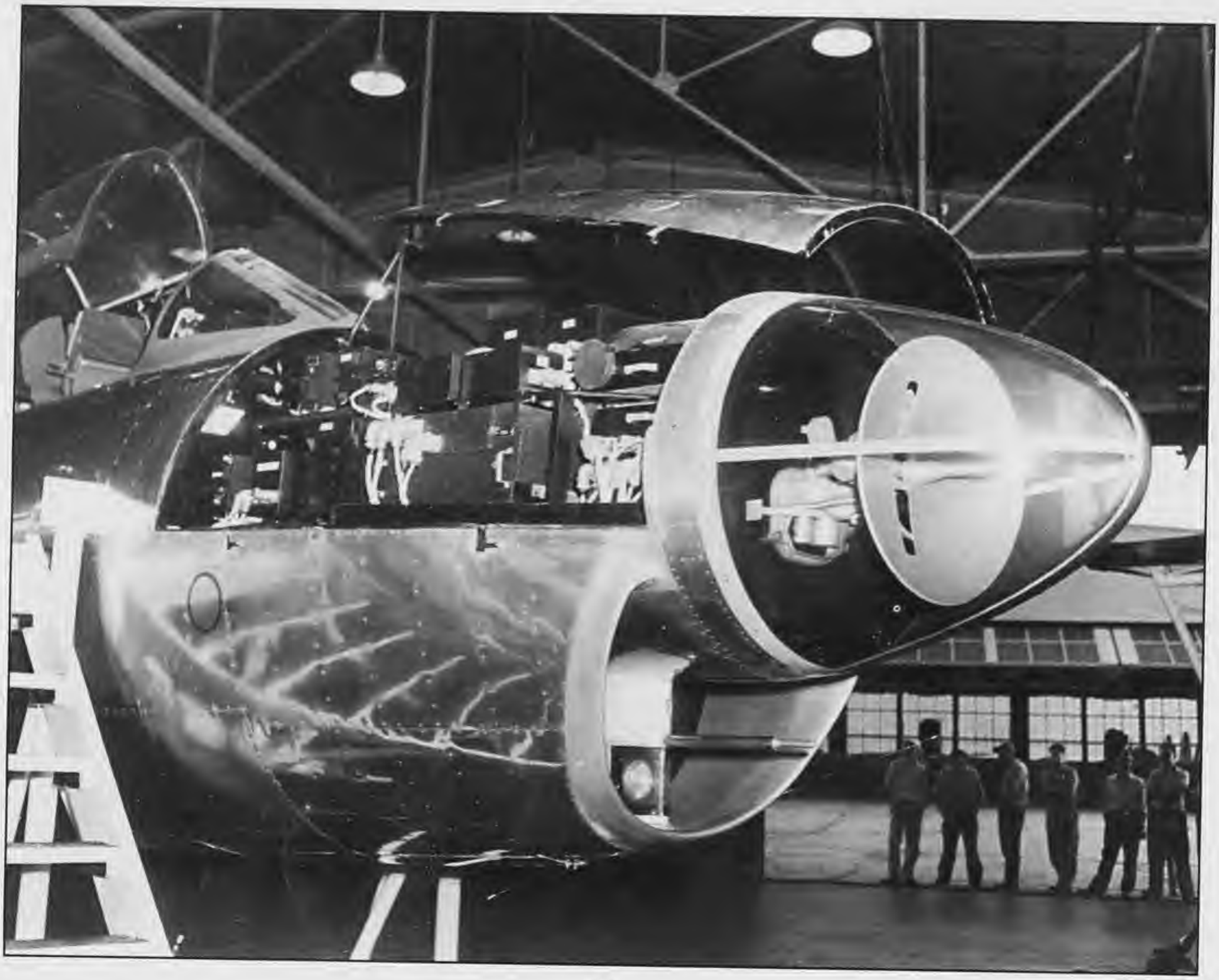
Above, right side view of butterfly tail configuration with smaller drop tanks used for jet fuel only. At right, rear view of the butterfly tail configuration. Below, 3/4 rear view of the butterfly tail configuration. Note aft fin-tip has position lights installed. (AFFTC/HO)

PROPOSED F-91B CONFIGURATION INSTALLED ON 46-8860

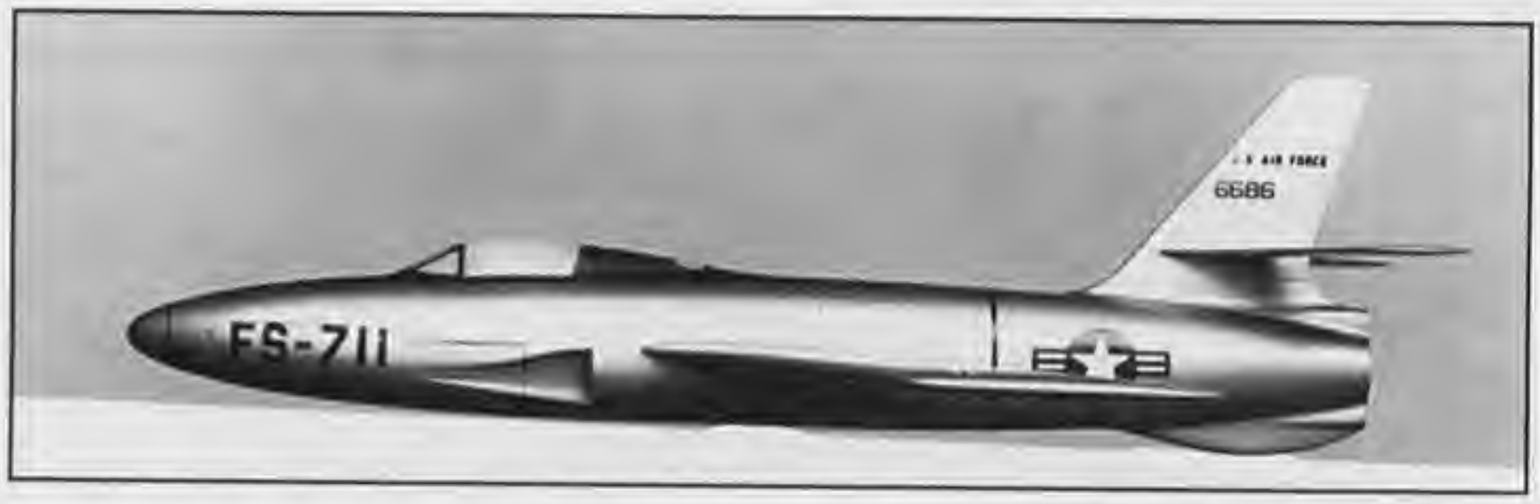
Above, posing side-by-side at the still highly restricted North Base facility at Edwards AFB were both of the XF-91 airplanes sporting their final configurations. On the left is XF-91 number one (46-680) with its F-86D/K/L styled nose. On the right is XF-91 number two (46-681) with its V-tail empennage. (AFFTC/HO) At left, head-on view with radome nose installed on the ramp at Edwards AFB. (via Pima Air and Space Museum) Below and right, upper views of the number one ship in its final F-91B test configuration with large nose radome. (AFFTC/HO)


U.S.A.F

Above, number two ship in its final configuration at the US Air Force Museum. (USAF) Below, radar and radio equipment mock-up installed on the re-worked nose of 46-6681. (Republic via Cradle of Aviation Museum)



Above, XF-91A mock-up shows the nose as installed on the XF-91s in their final configuration. (Republic via Cradle of Aviation Museum) At right, 1/32 scale model of the F-91A radar nose proposal with fuselage-mounted NACA style inlet ducts. (Republic via Cradle of Aviation Museum) Below, number one XF-91 being subjected to wing stress tests in 1949. (Republic)



THUNDERCEPTER STRUCTURES AND SYSTEMS

GENERAL DESCRIPTION:

The XF-91 Thunderceptor was an experimental single seat, turbojet- and rocket-powered, mid-wing, high-altitude and high-speed fighter-interceptor that was built by the Republic Aircraft Corporation. The fuselage is semi-monocoque in design and of all-metal stress-skin construction. The wings were designed with reverse taper, cathedral, sweptback, and full cantilever and included full span slats in the leading edge. The wing incidence was variable during flight. The primary propulsion system was comprised of a single turbojet engine, General Electric Model TG-190-B1, USAF Model J47-GE-7, modified to incorporate an afterburner section. However, other versions of the J47 were also used. The empennage is of a full cantilever design and all of the tail surfaces are sweptback. The cockpit canopy and the pilot's seat were jettisonable. Each main landing gear mounted two wheels, arranged in tandem, which retracted outboard into wheel wells in the wing.

PRINCIPAL DIMENSIONS:

Length (overall) - 43 feet, 3 inches

Height (static) - 18 ft, 1-3/16 in

Wingspan - 31 ft, 2.7 in

Wing sweepback (at 50% chord) - 40°

Wing area - 320 square feet

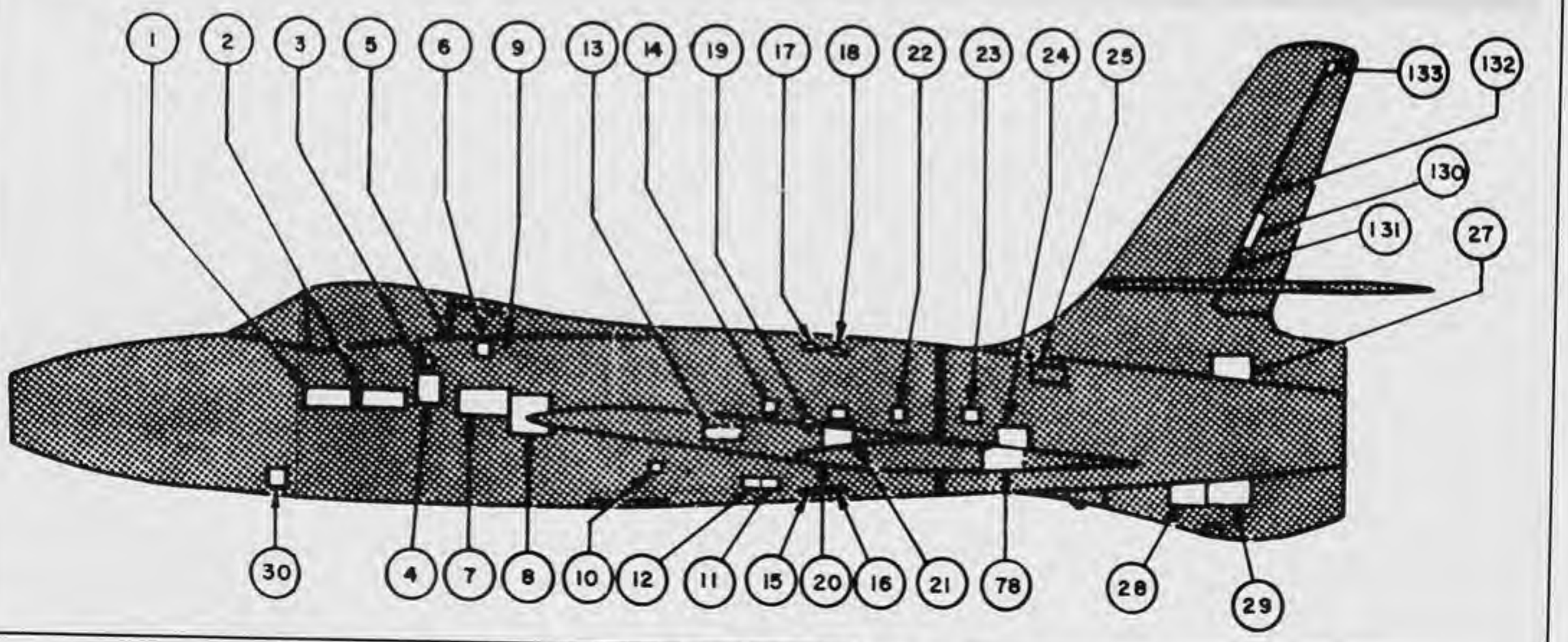
Fuel capacity (46-680) - 559 U.S. gallons (fuselage) - Jet Petroleum (JP)

Fuel capacity (46-681) - 231 U.S. gal (fuselage) - JP; forward fuselage LOX tank - 50 U.S. gal; aft fuselage LOX tank - 87 U.S. gal; fuselage water-alcohol tank - 191 U.S. gal

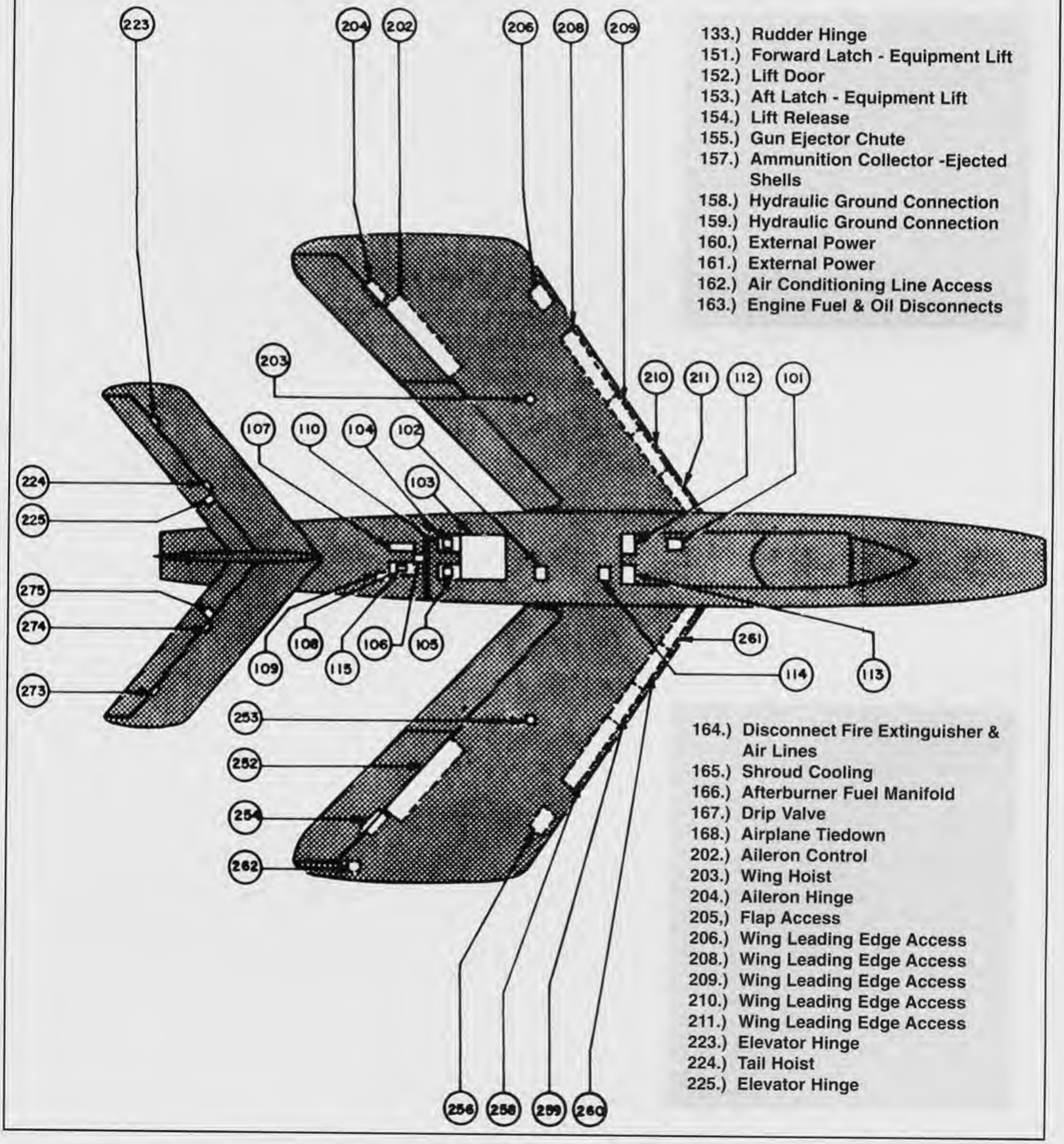
Wing tanks (two droppable three-segment) - 60 U.S. gal JP each; 216 U.S. gal LOX each; 265 U.S. gal water-alcohol each

ACCESS PANELS:

1.) Hydraulic Equipment
2.) Hydraulic Equipment
3.) Canopy & Outside Handle
4.) Ammunition Box
5.) Turtle Deck Access
6.) Hydraulic Reservoir
7.) Hydraulic Emergency Reservoir & Aileron Boost
8.) Screw Jack & Wing Installation
9.) Hoist Fuselage
10.) Fuel Filter & Sump Drains
11.) Static Drain
12.) Oil & Fuel Transmitter
13.) Oil Line Drain & Flight Controls
14.) Amplifier & Vent
15.) Fuselage Hoist & Splice Bolts
16.) Fuselage Splice Bolts
17.) Fuselage Hoist & Splice Bolts
18.) Fuselage Splice Bolts
19.) Oil Filter
20.) Jack Pad
21.) Controls
22.) Controls & Fuel Drain
23.) Fuel Drain
24.) Tail Pipe & Spark Plug
25.) Tank Access
27.) Rocket
28.) Clam Shell Actuator
29.) Rocket
30.) Lower Gun Access
51.) Ammunition Box
52.) Turtle Deck Access
53.) Hoist Fuselage
54.) Hydraulic Emergency Reservoir & Aileron Boost
55.) Screw Jack & Wing Installation
56.) Oil Line Drain & Flight Controls
57.) Fuselage Splice Disconnects
58.) Controls
59.) Jack Pad
60.) Fuselage Hoist & Splice Bolts
61.) Fuselage Splice Bolts
62.) Fuselage Hoist & Splice Bolts
63.) Fuselage Splice Bolts
64.) Controls & Fuel Drain
65.) Controls & Fuel Drain
66.) Tail Pipe & Spark Plug



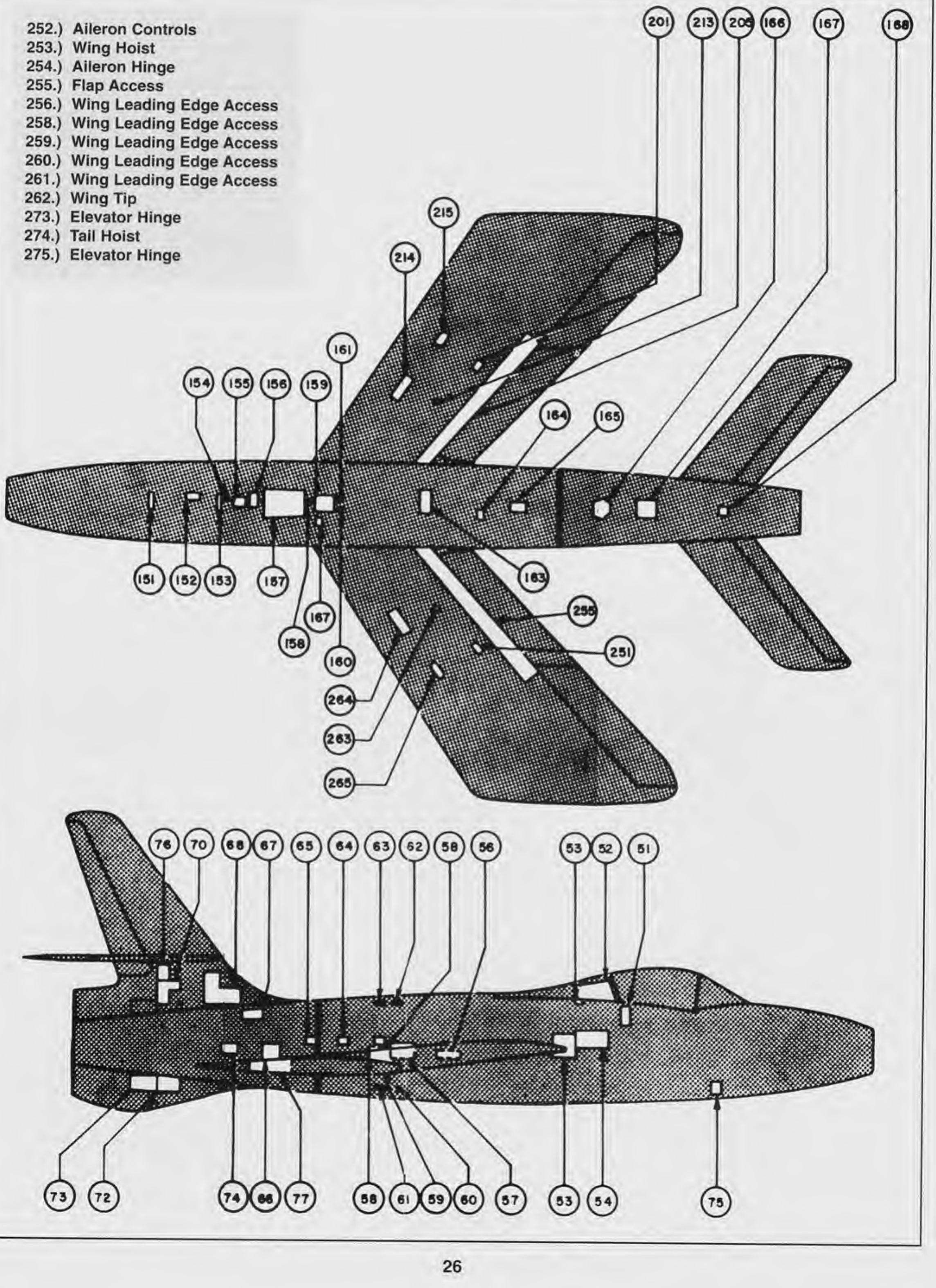
67.) Tank Access
68.) Afterburner Control Amplifiers
69.) Elevator Booster
70.) Elevator Booster
71.) Rocket
72.) Clam Shell Actuator
73.) Rocket
74.) Elevator Control
75.) Lower Gun Forward Access
76.) Elevator Tab Motor
77.) Electrical Box
78.) Electrical Box
101.) Lox Filler Cap
102.) Scupper & Tank Filler
103.) Pump House
104.) Tank Access & Fuel Filler
105.) Tank Access & Fuel Filler
106.) Tank Vent Line
107.) Tank Access & Fuel Filler
108.) Helium Filler
109.) Scupper Drain Connection
110.) Tank Access & Fuel Filler
114.) Access Forward fuel Cell
115.) Tank Access & Fuel Filler
130.) Rudder Tab Control
131.) Rudder Hinge
132.) Rudder Hinge



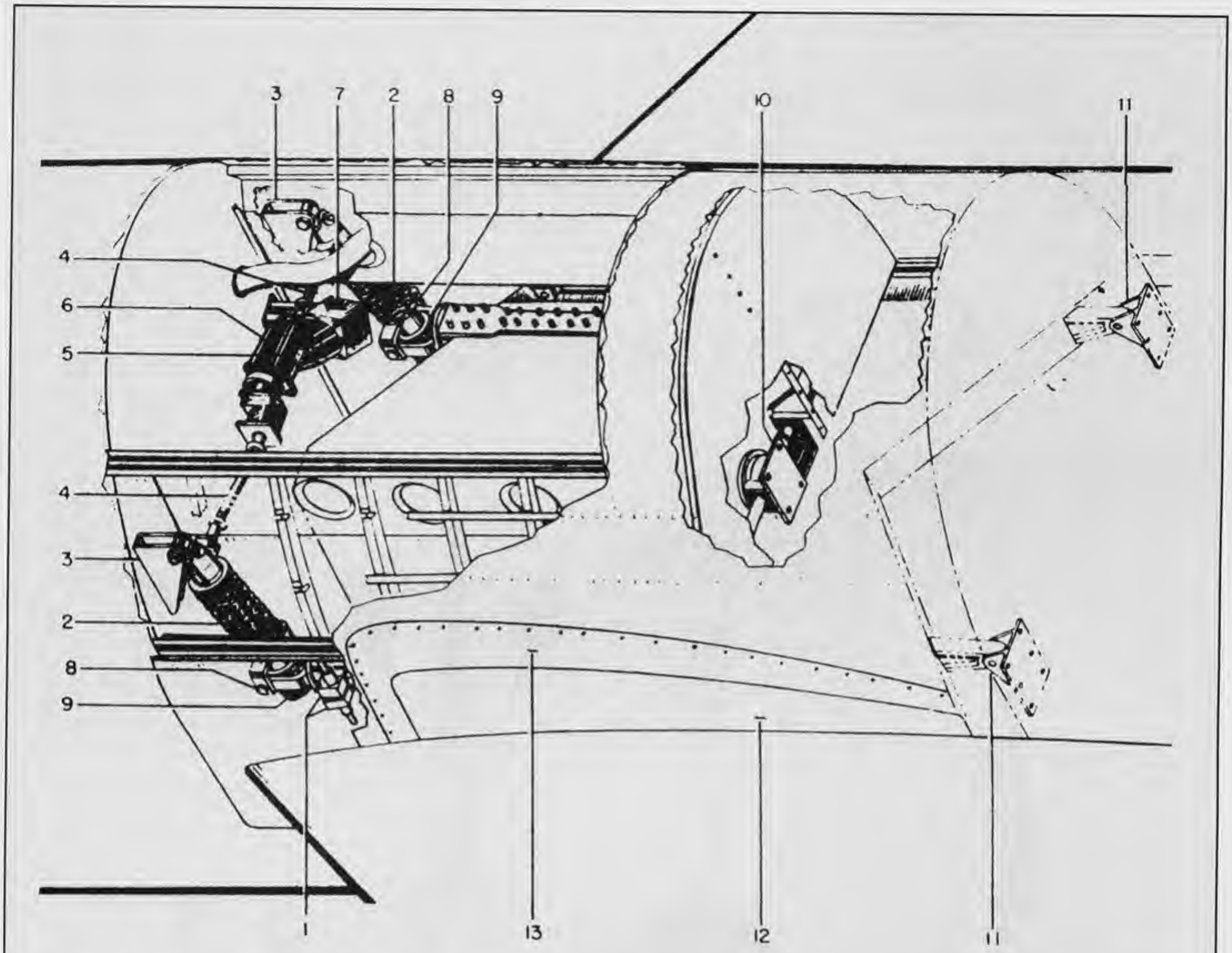
133.) Rudder Hinge
151.) Forward Latch - Equipment Lift
152.) Lift Door
153.) Aft Latch - Equipment Lift
154.) Lift Release
155.) Gun Ejector Chute
157.) Ammunition Collector -Ejected Shells
158.) Hydraulic Ground Connection
159.) Hydraulic Ground Connection
160.) External Power
161.) External Power
162.) Air Conditioning Line Access
163.) Engine Fuel & Oil Disconnects

164.) Disconnect Fire Extinguisher & Air Lines
165.) Shroud Cooling
166.) Afterburner Fuel Manifold
167.) Drip Valve
168.) Airplane Tiedown
202.) Aileron Control
203.) Wing Hoist
204.) Aileron Hinge
205,) Flap Access
206.) Wing Leading Edge Access
208.) Wing Leading Edge Access
209.) Wing Leading Edge Access
210.) Wing Leading Edge Access
211.) Wing Leading Edge Access
223.) Elevator Hinge
224.) Tail Hoist
225.) Elevator Hinge

252.) Aileron Controls
253.) Wing Hoist
254.) Aileron Hinge
255.) Flap Access
256.) Wing Leading Edge Access
258.) Wing Leading Edge Access
259.) Wing Leading Edge Access
260.) Wing Leading Edge Access
261.) Wing Leading Edge Access
262.) Wing Tip
273.) Elevator Hinge
274.) Tail Hoist
275.) Elevator Hinge

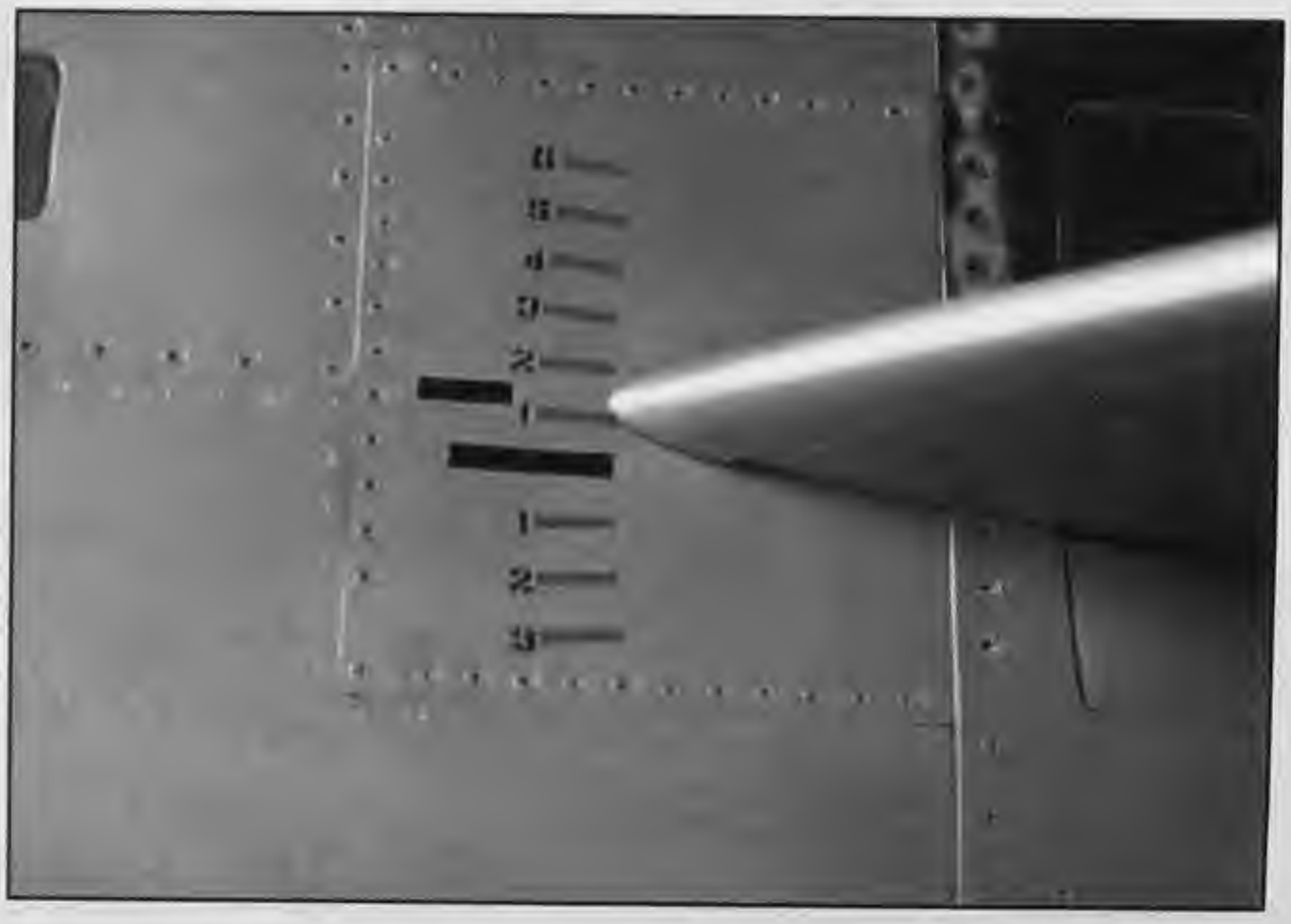


WING INCIDENCE CONTROLS

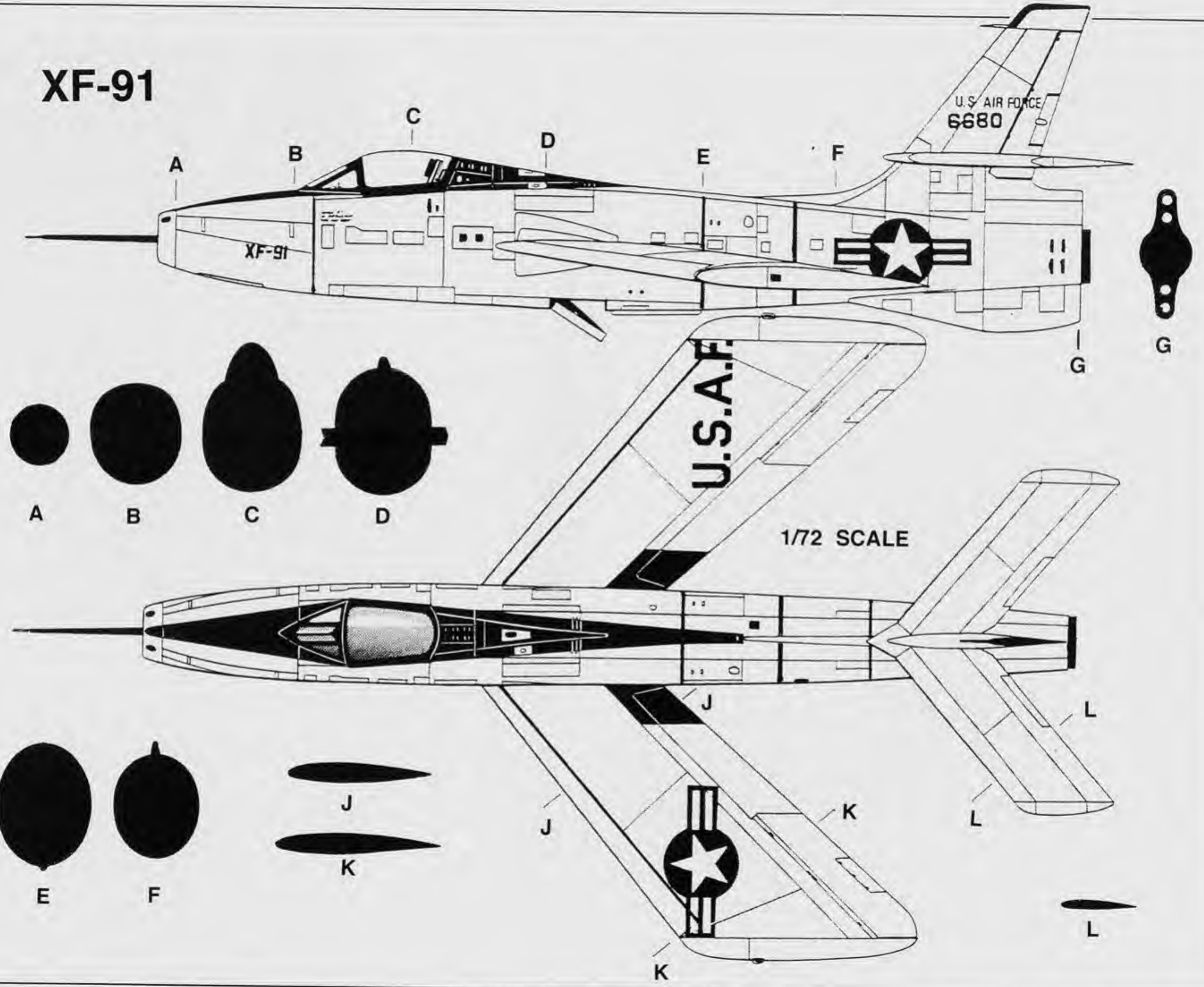


1.) Wing Incidence Limit Switches
2.) Screw Jack and Boot
3.) Screw Jack Upper Mounting
4.) Screw Jack Drive Shaft
5.) Brake Unit Inspection Door
6.) Gear Box
7.) Hydraulic Motor Gear Box Drive
8.) Screw Jack Wing Attaching bolt
9.) Screw Jack Lower Boot
10.) Fuel Shutoff Valve
11.) Wing Attaching Bolt
12.) Wing Incidence Shield
13.) Wing Fuselage Shield

At right, close-up of wing incidence degree markings on the fuselage in front of the wing's leading edge. Thin lines were red, numbers and thick lines were black. (R. Williams via Wayne Morris)



XF-91


A
B
C
D
E
F
G
U.S. AIR FORCE
66-80
XF-91
U.S.A.F.
G
A
B
C
D
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F
J
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J
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1/72 SCALE
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K
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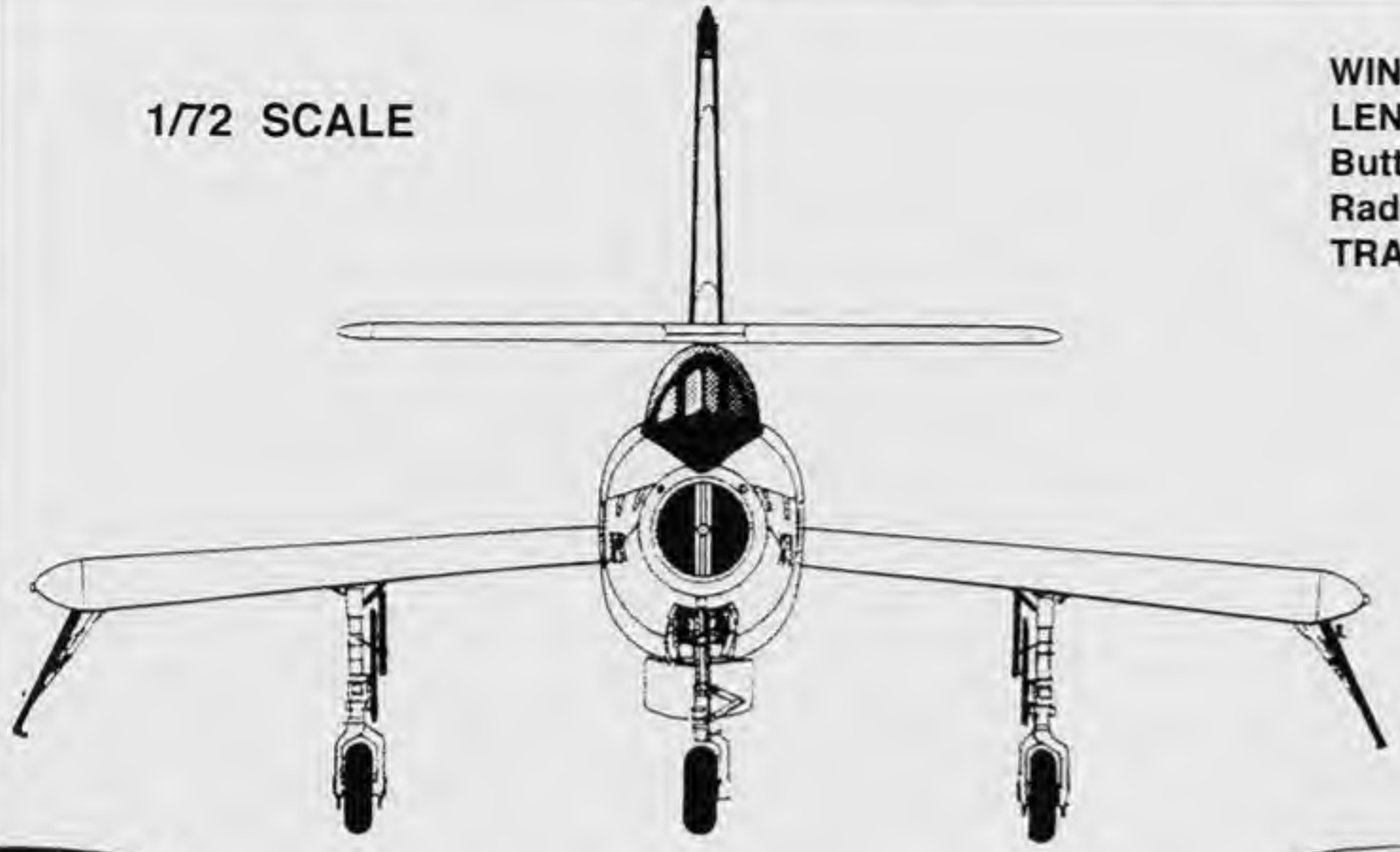
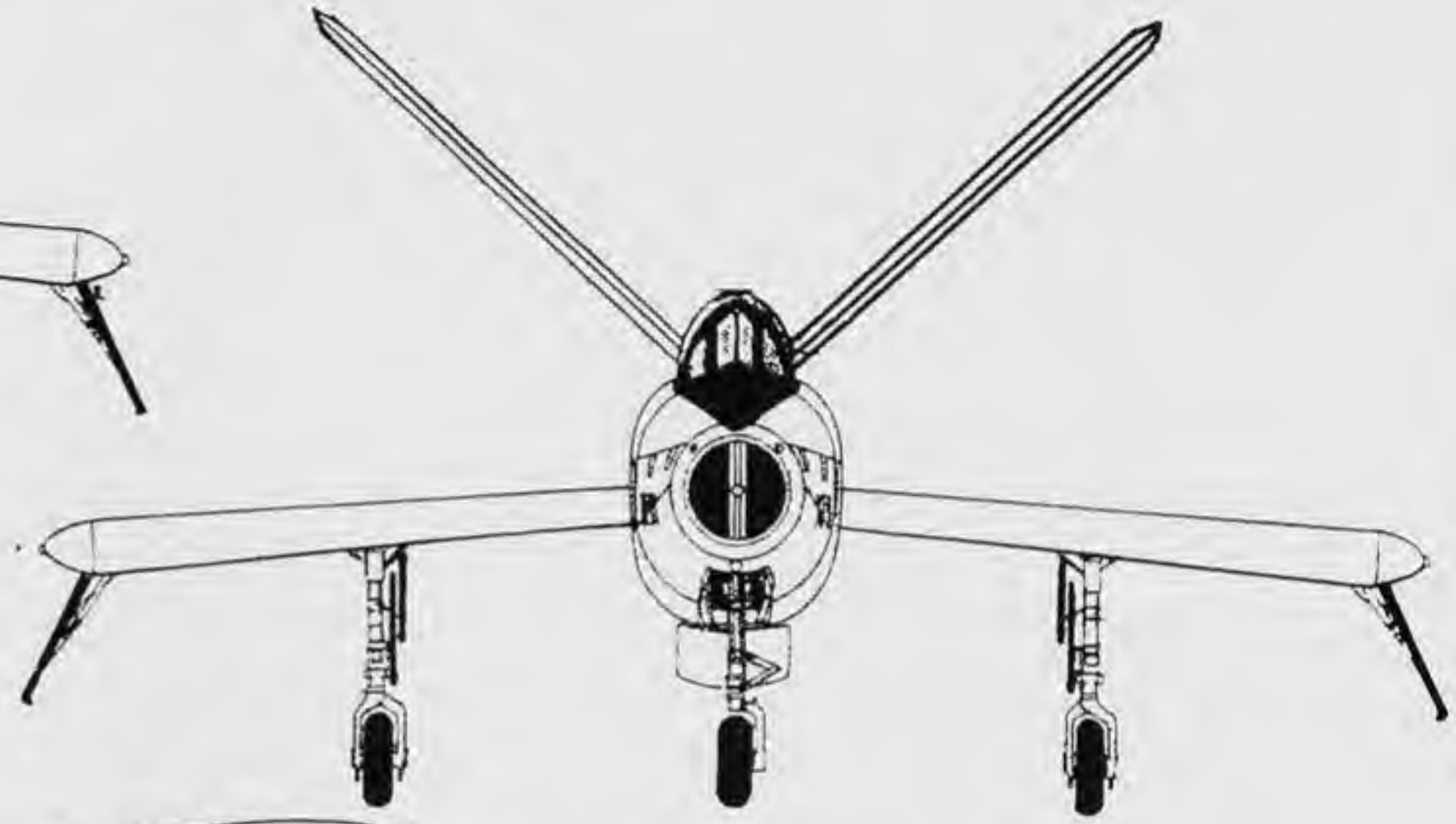
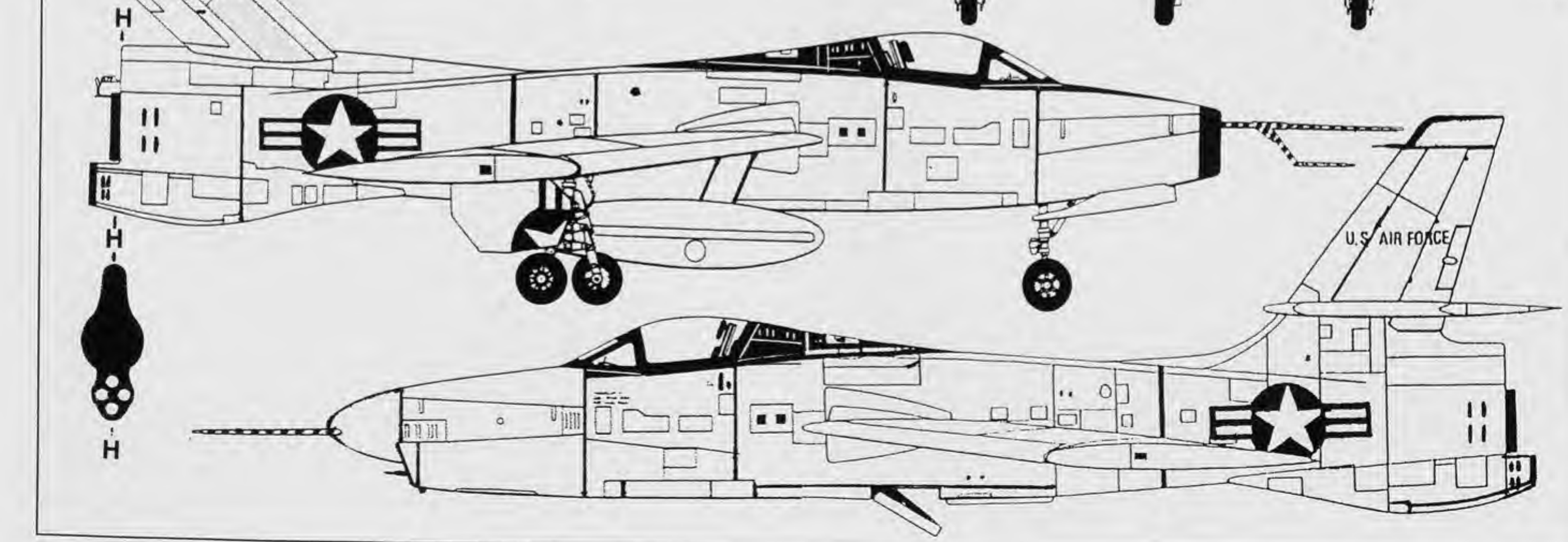
1/72 SCALE

WINGSPAN:	31 feet 3 inches	WING AREA:	320 square feet
LENGTH:	43 feet 3 inches	HEIGHT:	18 feet 1 inch
Butterfly Tail:	47 feet 6 inches	HEIGHT:	16 feet 6 inches
Radome Nose:	46 feet 9 inches	HEIGHT:	18 feet 1 inch
TRAC:	15 feet 5 inches		





XF-91



XF-91 ARMAMENT

ARMAMENT:

The original primary armament was to be four nose-mounted 20 millimeter (mm) M-3 cannon with 200 rounds of 20 mm ammunition per gun. There were several other armament arrangements that had been considered for production F-91 Thunderceptor application:

1.) The proposed F-91-1 was to carry four T-110 cannon with 15 rounds of T-131 ammunition each.

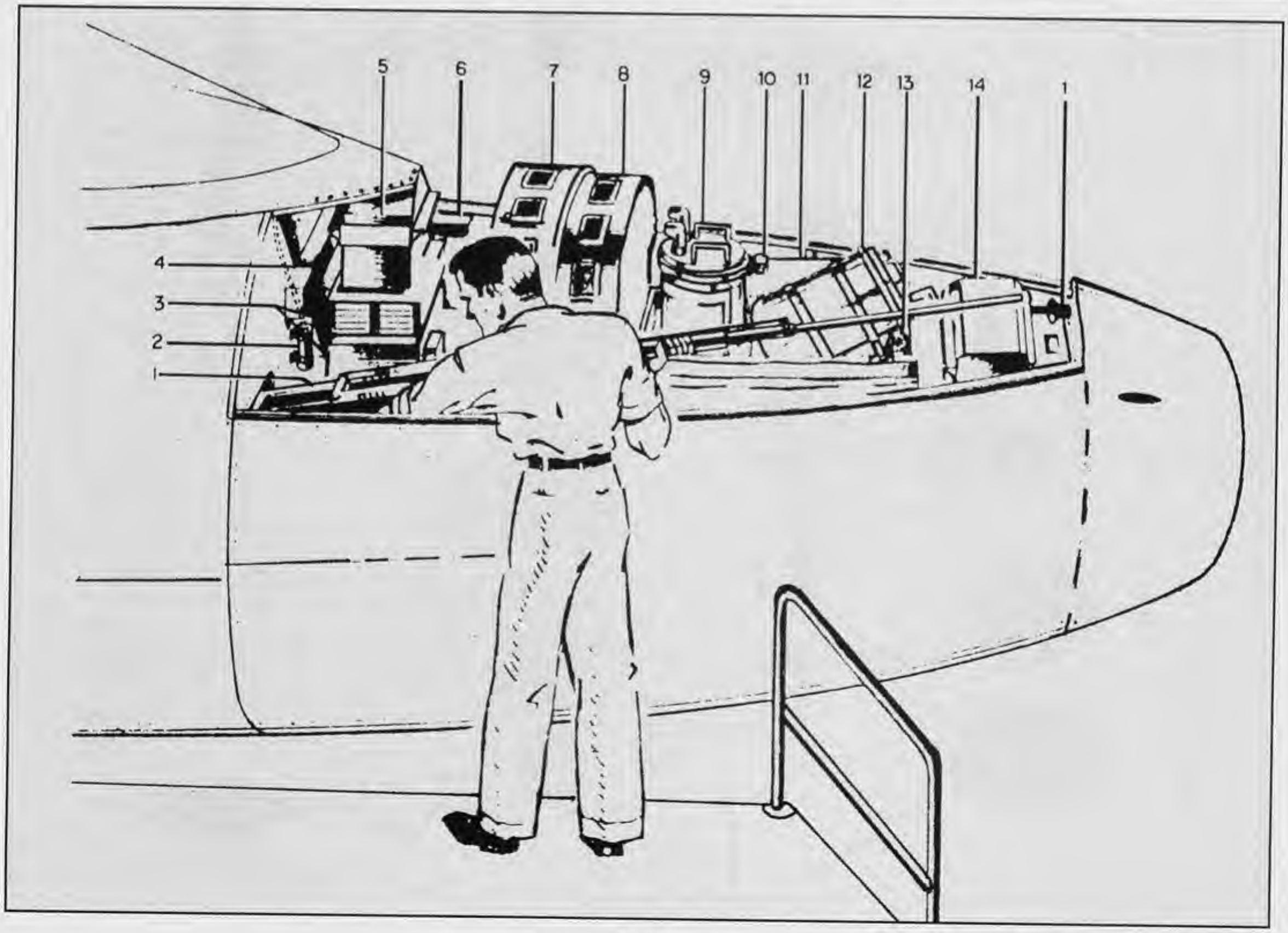
2.) The proposed F-91-2 was to carry four Hughes Falcon air-to-air missiles (AAM) internally on two retractable side-by-side rails on centerline in the lower fuselage.

3.) The F-91-3, as an interim measure until the T-110 cannon and T-131 ammunition was available, was to be armed with four nose-mounted M-24 20mm cannon with 200 rounds per gun. (When the T-110/T-131 became available, the F-91-3 was to be reconfigured to accept that armament package, reverting to F-91-1 status.)

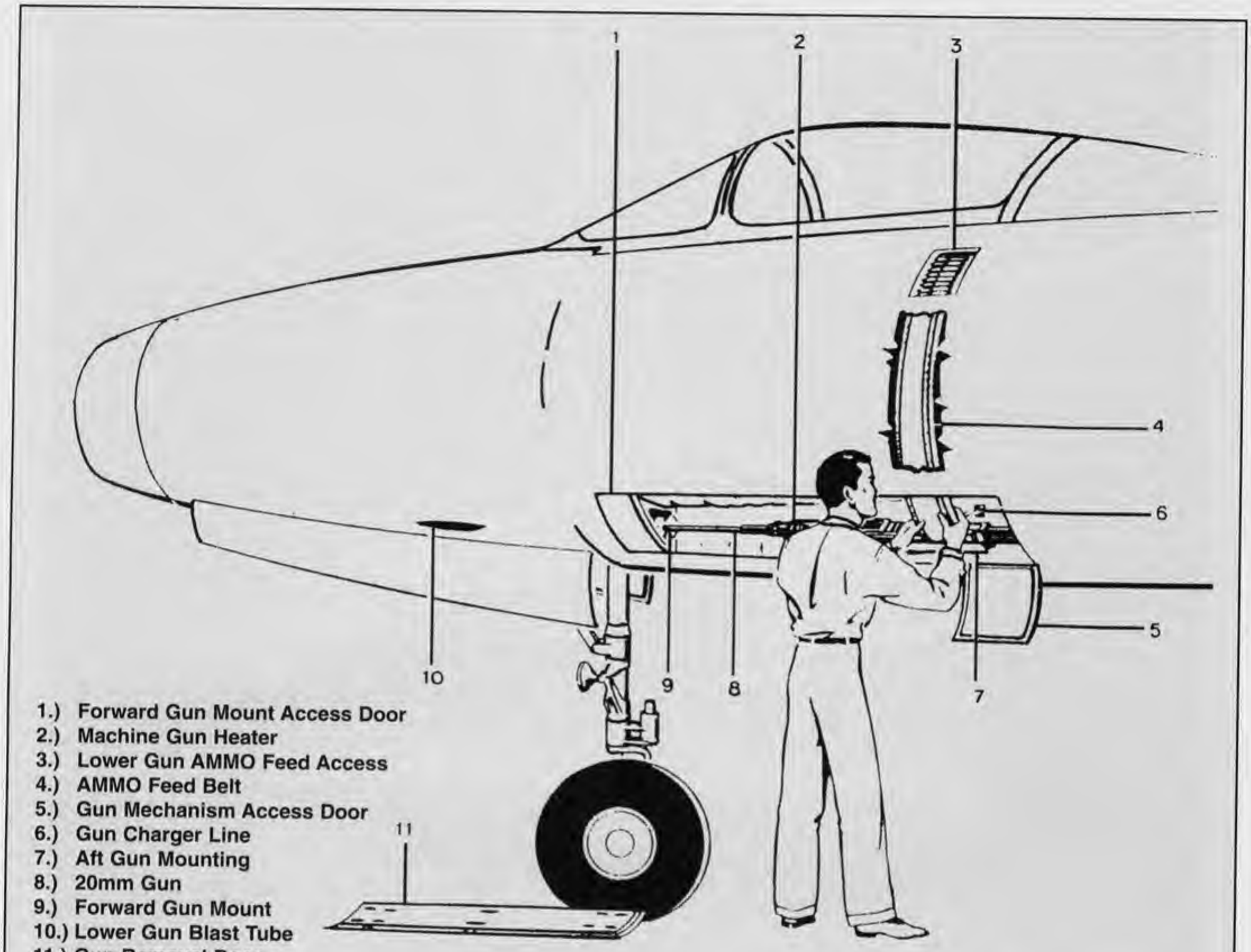
Initially developed as the XF-98 Interceptor Rocket under the project code name Dragonfly, the Hughes Aircraft XF-98 Falcon began life in 1947 as the Experimental Guided Aerial Rocket, Model One (XGAR-1) under Secret Project MX-904. Hughes was contracted to develop four models of its Falcon - GAR-1, GAR-2, GAR-3 and GAR-4, each type having different characteristics. The Falcon was the first air-to-air guided rocket to be adopted by the USAF for use on its fighters and interceptor aircraft. Eventually the GAR prefix was changed to AIM for Air Intercept Missile and the first four versions of the Falcon were all re-designated AIM-4 but with different suffix letters to denote their individual mission requirement.

At right, upper gun deck with two M-24 20mm cannons installed. (Republic via Cradle of Aviation Museum)

1.) 20mm Gun
2.) Windshield Dryer
3.) SCR-695-B Radio & Power Unit
4.) Junction Box Radar Gunsight
5.) Computer Radar Gunsight
6.) Radar Range Gear Box
7.) AMMO Box - Right
8.) AMMO Box - Left
9.) Radar Range Unit
10.) Blower Range Unit
11.) Oxygen Bottle Pilot
12.) Radar Reciever Transmitter
13.) Blower Reciever Transmitter
14.) Sight Servo Amplifier



LOWER 20MM CANNON INSTALLATION

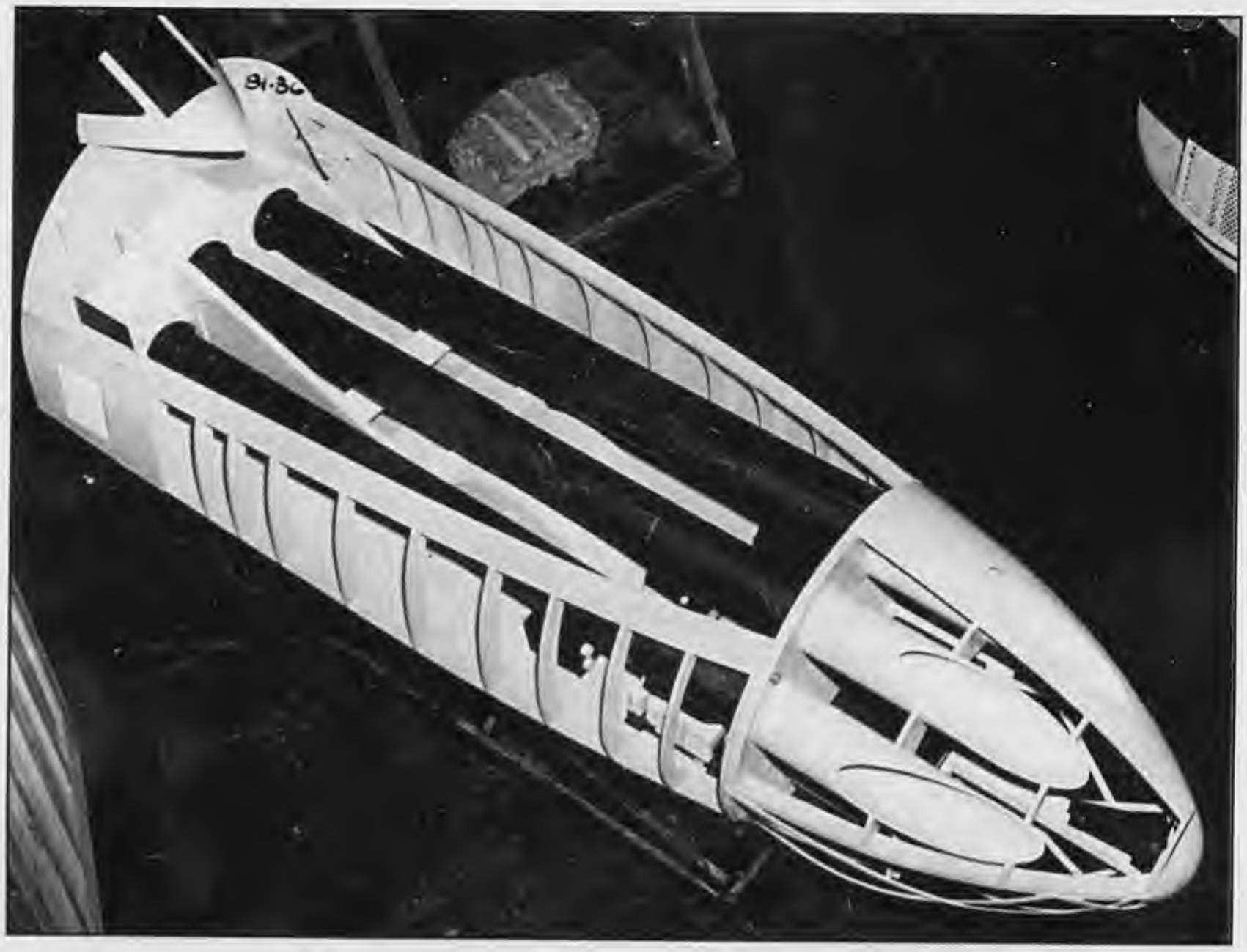


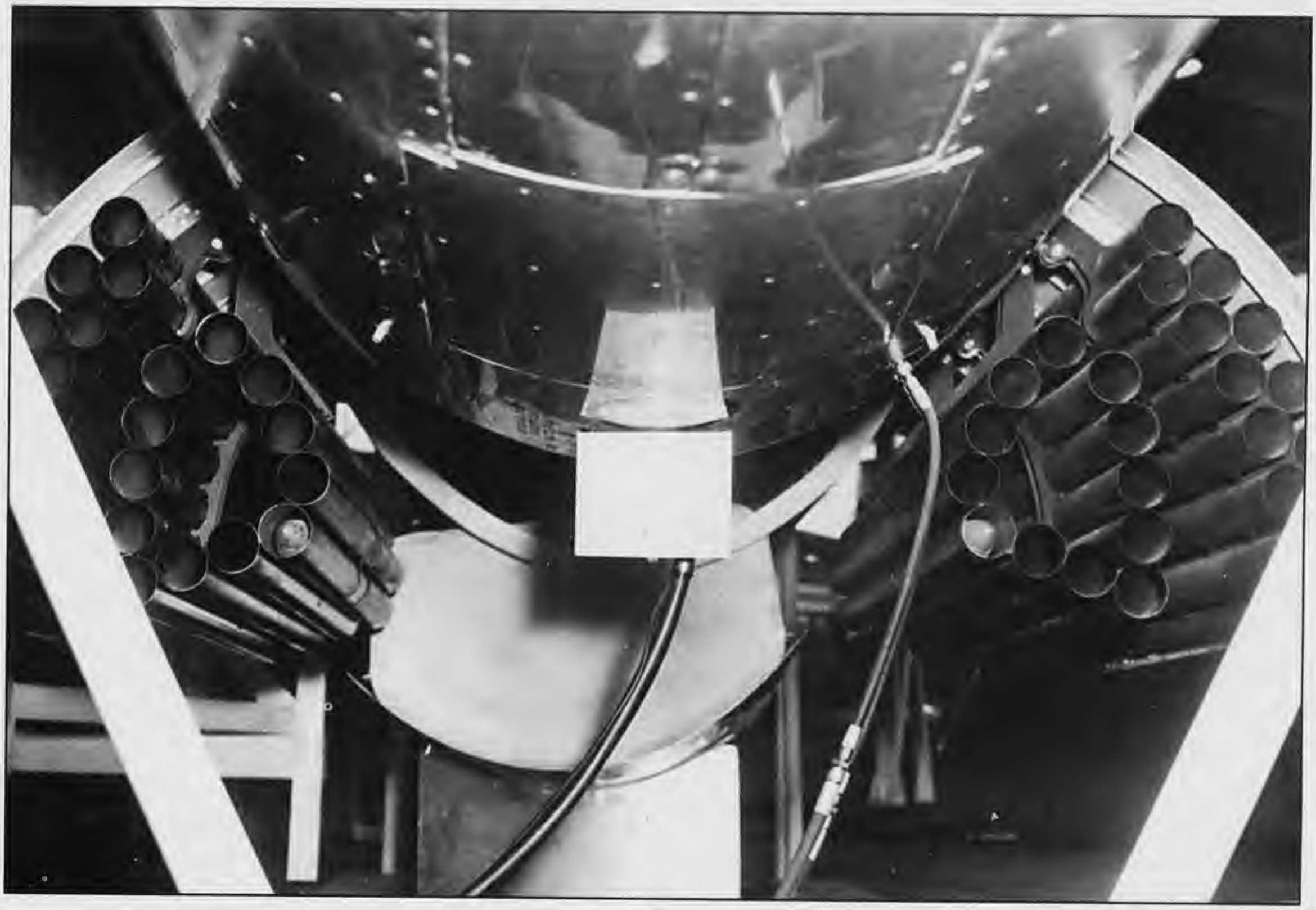
1.) Forward Gun Mount Access Door
2.) Machine Gun Heater
3.) Lower Gun AMMO Feed Access
4.) AMMO Feed Belt
5.) Gun Mechanism Access Door
6.) Gun Charger Line
7.) Aft Gun Mounting
8.) 20mm Gun
9.) Forward Gun Mount
10.) Lower Gun Blast Tube
11.) Gun Removal Door

At left, Republic Aviation president, Mundy I. Peale announces the XF-91 hy-bred rocket interceptor to the public in 1947. Mr. Peale was president of Republic Aviation from 1947 though 1965. He had managed Republic's Evansville plant that built P-47 Thunderbolts during World War Two. (via Steve Pace)

PROPOSED ROCKET ARMAMENT

At right, an armament mock-up showing the proposed rocket nose for the unbuilt F-91B whereby unguided 5-in high-velocity aerial rockets (HVAR) were to be used. (Republic via Cradle of Aviation Museum) Below, another proposed weapon system for production F-91s was this outward-opening door's arrangement, each door packed with 24 tubes for 2.75 in Mighty Mouse folding-fin aerial rockets (FFAR). (Republic via Cradle of Aviation Museum)





XF-91 INSTRUMENT PANEL WITH ROCKET PANEL AT TOP ON 6-29-52

COCKPIT:

The XF-91 cockpit "fit like a glove" and was literally a "fighter pilot's cockpit" whereby every control was easy to reach by the man at the helm. It featured one of the first uses of an emergency ejection seat for pilot escape in a crisis. (Ejection seats were then called "catapult seats").

It was pressurized to maintain a 10,000 ft cockpit altitude from 10,000 to 18,000 ft with a constant differential of 2.75 pounds per square inch above atmospheric pressure. Above 36,000 ft, a constant relative gas expansion rate of 2.3 was maintained.

The cockpit canopy consisted of a flat plate type windshield with a section that rose up and down for pilot ingress and egress. The movable part of the canopy was fully jettisonable for emergency escape.

FUSELAGE:

The fuselage was of a circular design of semi-monocoque all-metal, stressed skin construction.

WING:

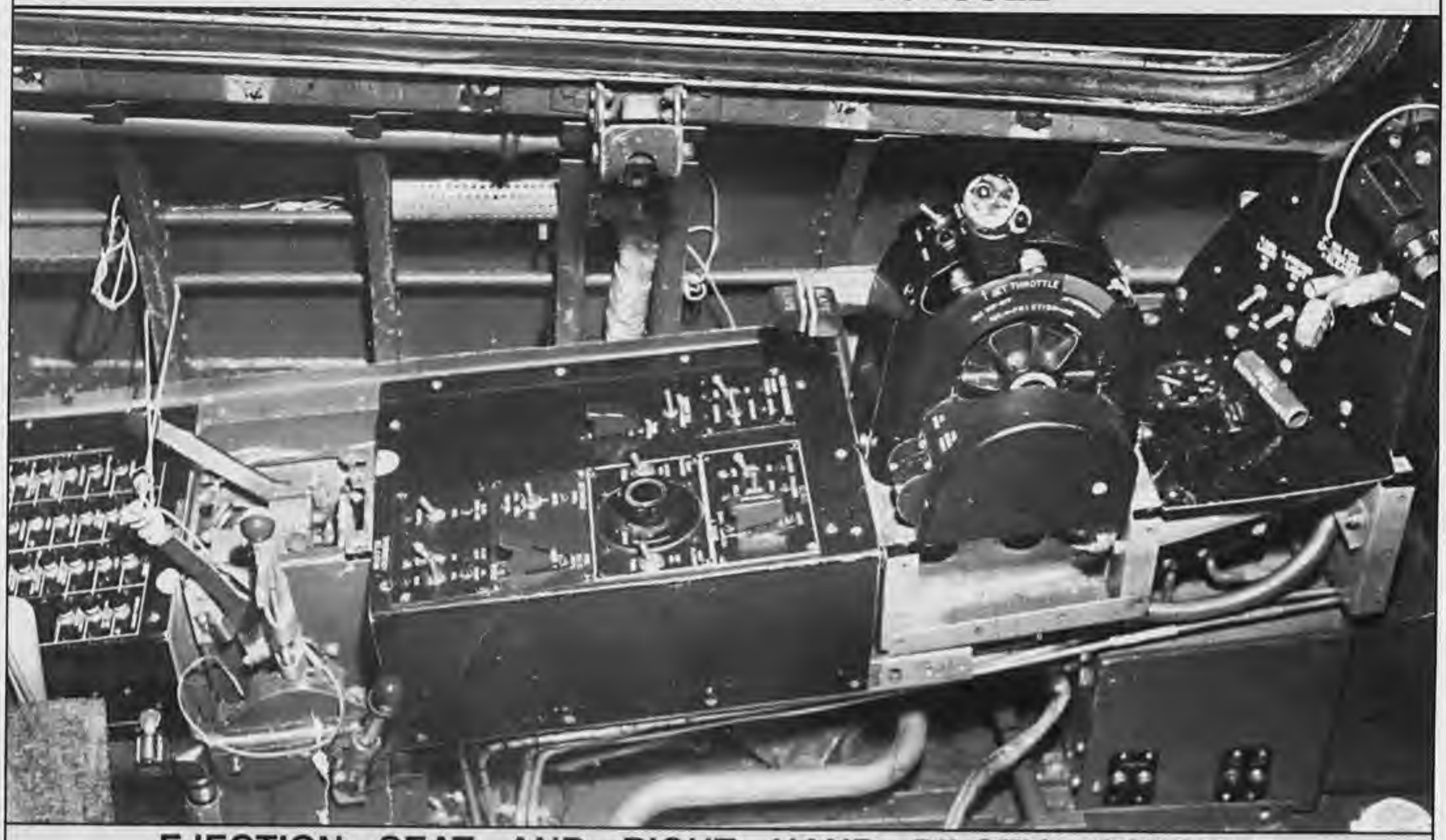
The XF-91 wing was unique to say the least. Its inverse taper configuration set it apart from any wing heretofore. It was of a full-cantilever, all-metal, stressed skin design.

The incidence of the wing was variable through a range of minus two degrees to plus six degrees (-2 to +6) with reference to the centerline of the fuselage.

EMPENNAGE:

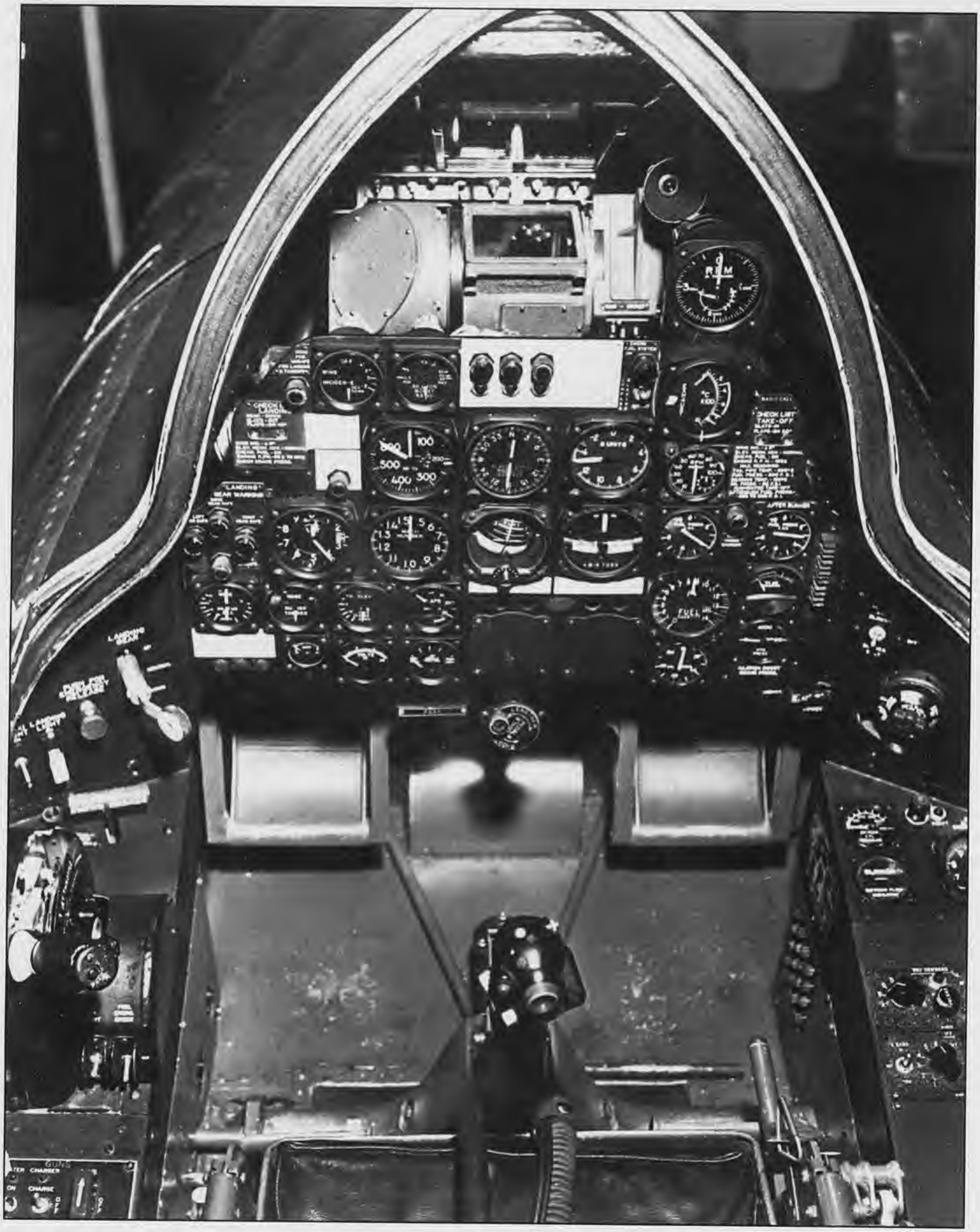
On most combat-type aircraft in the late 1940s, the empennage was comprised of two horizontal stabilizers with elevators and one vertical stabilizer with a rudder. But the XF-91 employed the use of two different types of tail groups. One with a single vertical tail/rudder configuration with two horizontal stabilizers/elevators, and the other with two outward-canted vertical tails with rudders. The latter was quite unique in its design; it was described as a "butterfly" or V-tail.

LEFT - HAND PILOT'S CONSOLE

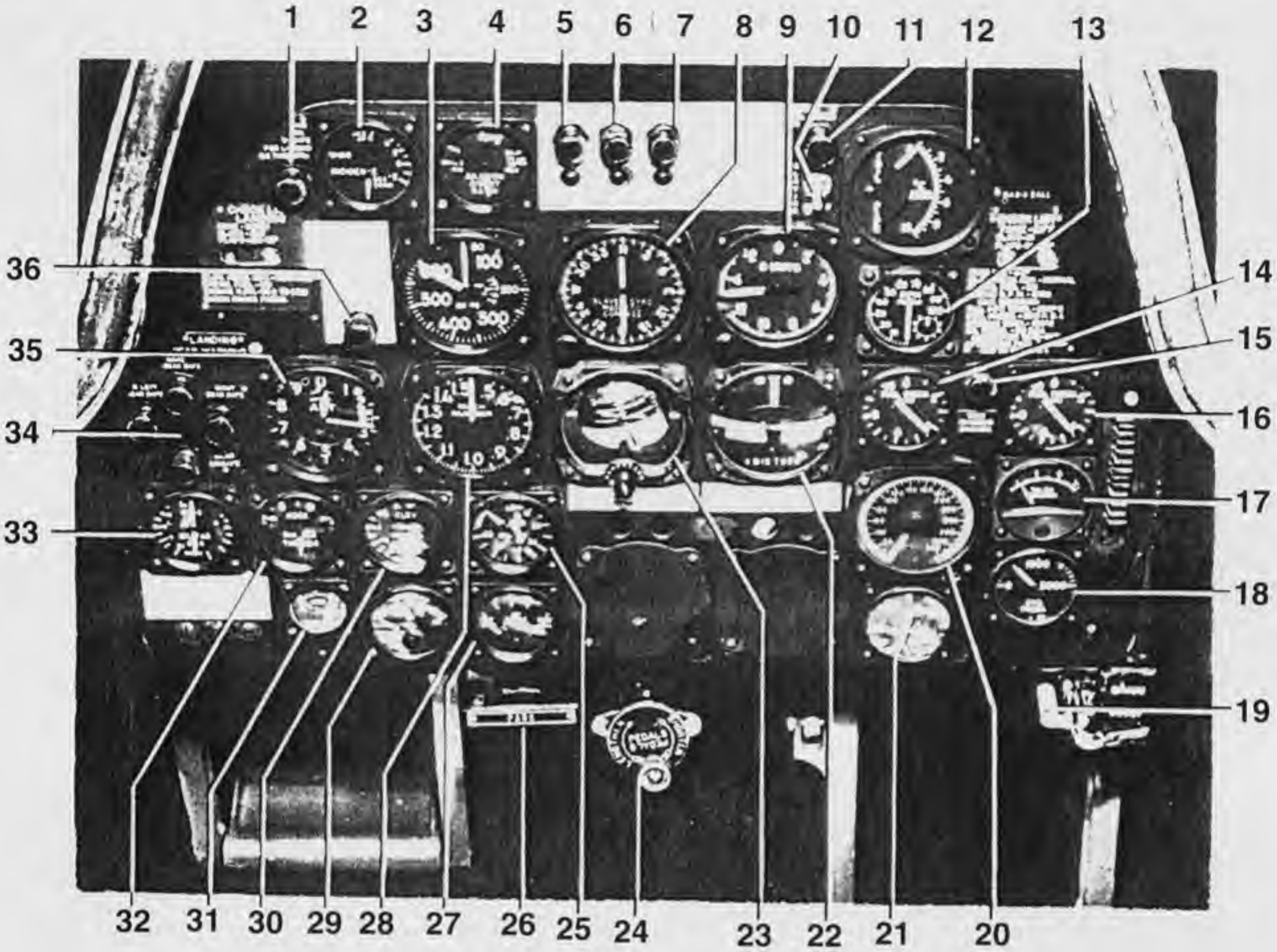


EJECTION SEAT AND RIGHT - HAND PILOT'S CONSOLE

XF-91 FORWARD COCKPIT

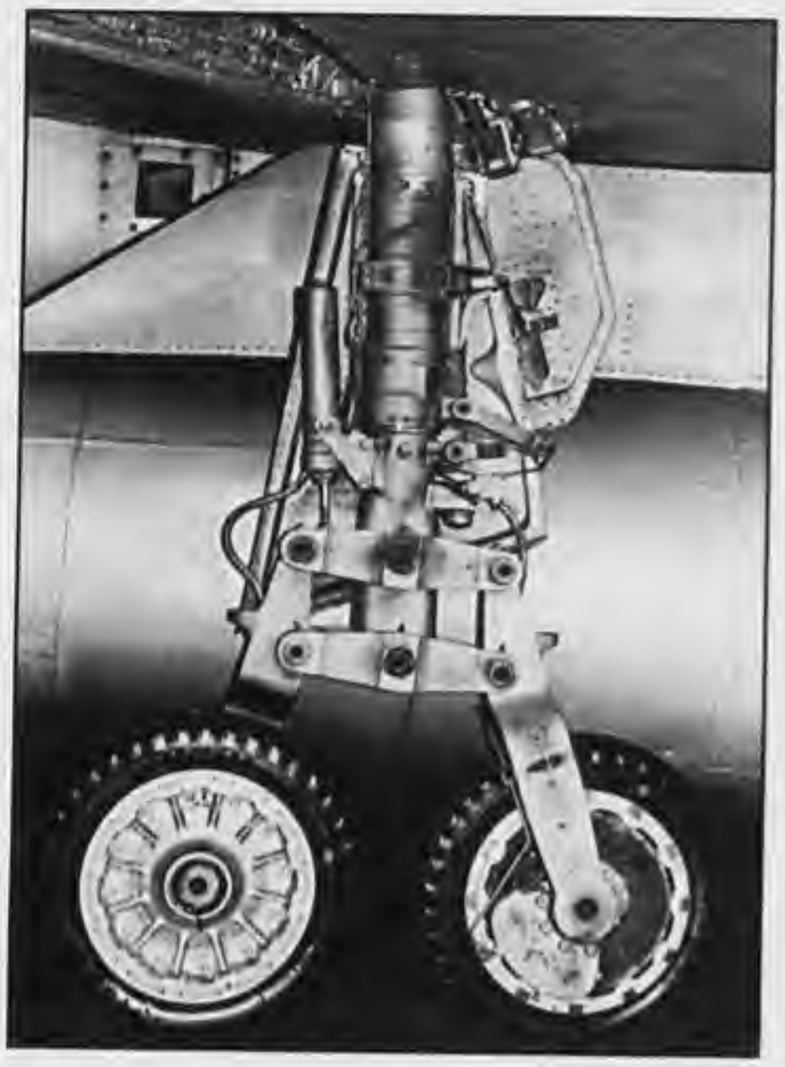


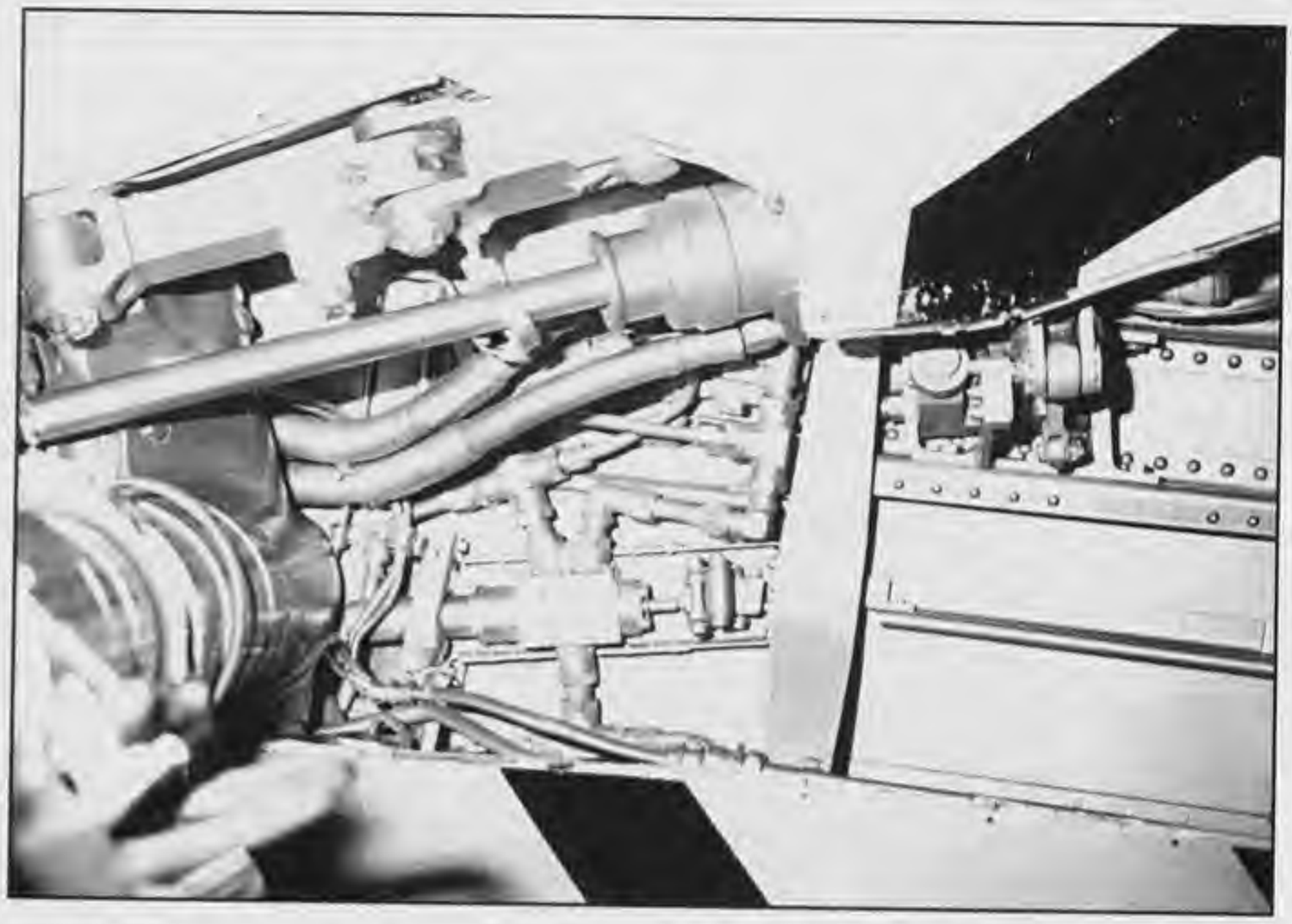
XF-91 INSTRUMENT PANEL



1.) Wing Incidence Warning Light
2.) Wing Incidence Angle Indicator
3.) Airspeed Indicator
4.) Aileron Boost Ratio Indicator
5.) Rocket Fire Indicator
6.) Engine Fire Indicator
7.) Engine Overheat Warning Light
8.) Slaved Gyro Magnetic Compass Indicator
9.) Accelerometer
10.) Compass Slaving Switch
11.) Emergency Fuel System Indicator Light
12.) Tail Pipe Temperature Indicator
13.) Tachometer
14.) Engine Fuel Pressure
15.) Fuel Tank Pressure Warning Light
16.) Afterburner Fuel Pressure
17.) Bearing Temperature Indicator
18.) Hydraulic Boost Pressure Gage
19.) Hydraulic Boost Pressure Selector Valve
20.) Fuel Quantity Gage
21.) Oil Pressure Gage
22.) Turn and Bank Indicator
23.) Attitude Gyro Indicator
24.) Rudder Pedal Adjustment
25.) Flap Position Indicator
26.) Parking Brake Control
27.) Jet Nozzle Position Indicator
28.) Mach Number Indicator
29.) Voltmeter
30.) Elevator Trim Tab Indicator
31.) Ammeter
32.) Rudder Tab Indicator
33.) Aileron Tab Indicator
34.) Landing Gear Position Indicator Lights
35.) Altimeter
36.) Dive Brake Warning Light

MAIN LANDING GEAR





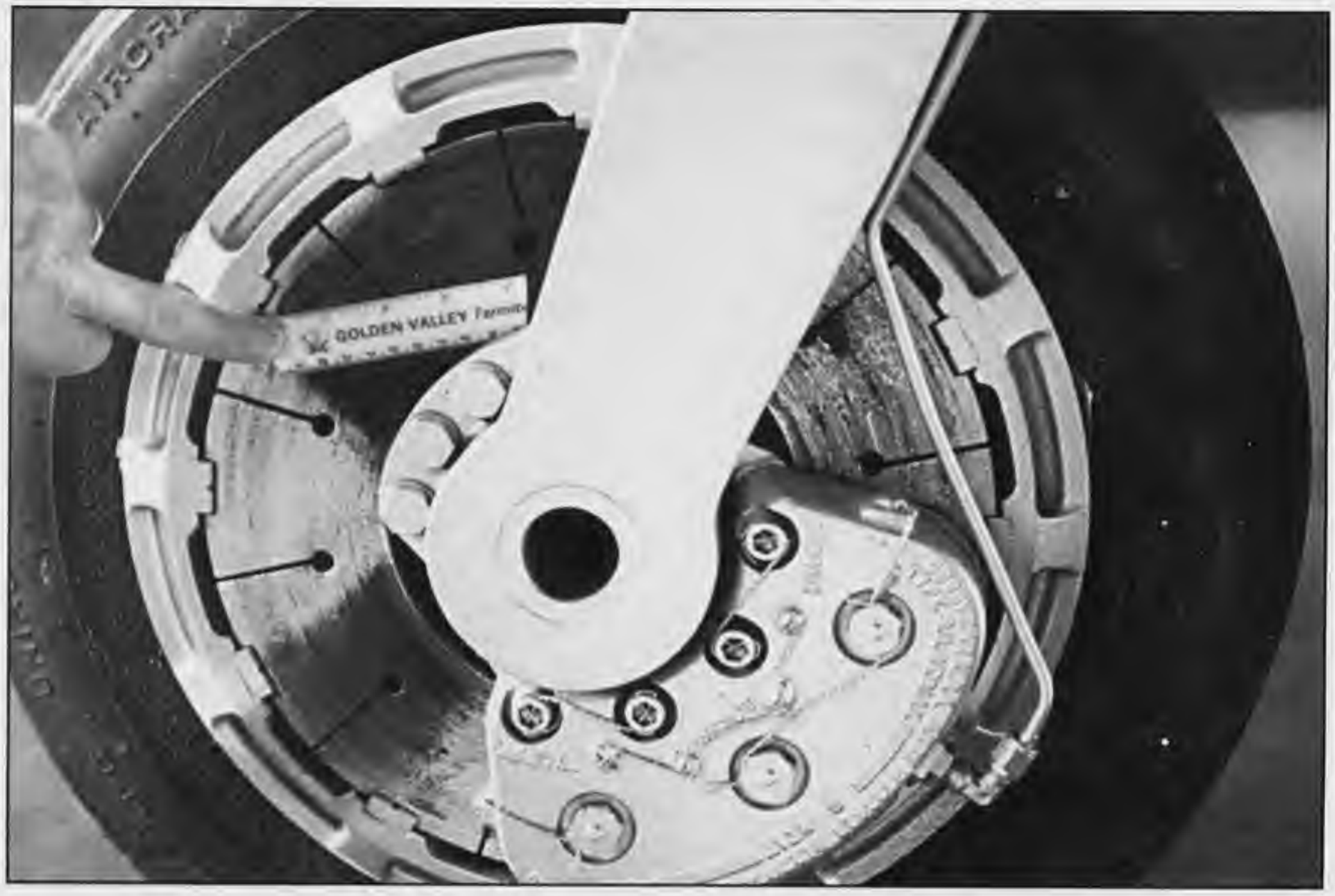
Above left, tandom-tired right main gear. Below, two views of the left main gear stut and gear doors looking aft. Above right, left main gear well inside portion (closest to fuselage), showing strut attachment point. Upper right (next page), left main gear well outer portion. At right (next page), left main gear disc brake system detail. (R. Williams via Wayne Morris)

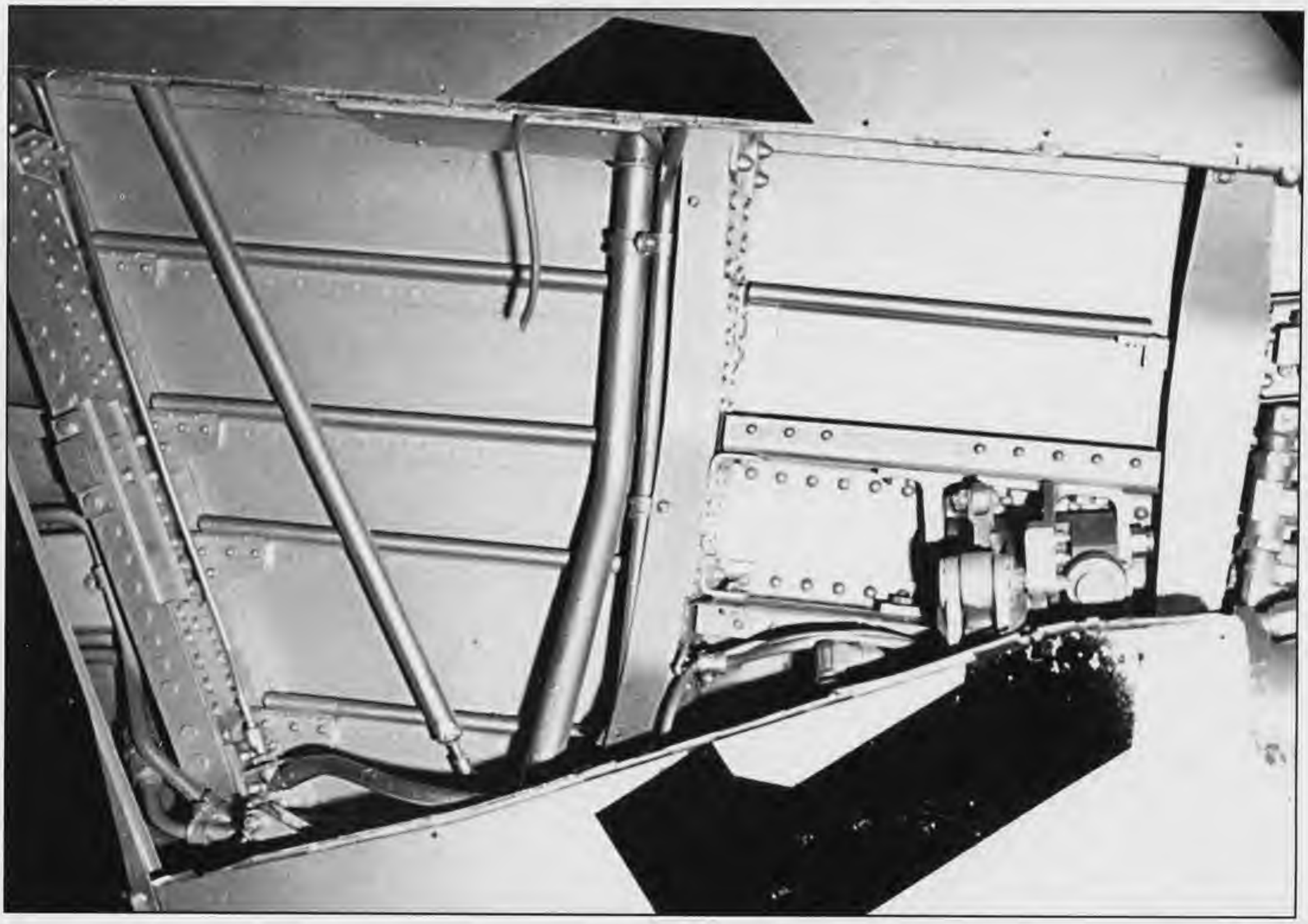
MAIN LANDING GEAR

LANDING GEAR:

The main landing gear was of a cantilever, dual-wheel type that retracted outboard into wheel wells in the outer, thicker part of the wing. Each leg had two 24-in diameter by 5.5-in wide Type VII B (extra high pressure) tires and wheels.

The nose landing gear had a single 22-in x 7.25 11.55-in Type VI (low profile) tire and wheel.





PROPULSION SYSTEM

PROPULSION SYSTEM:

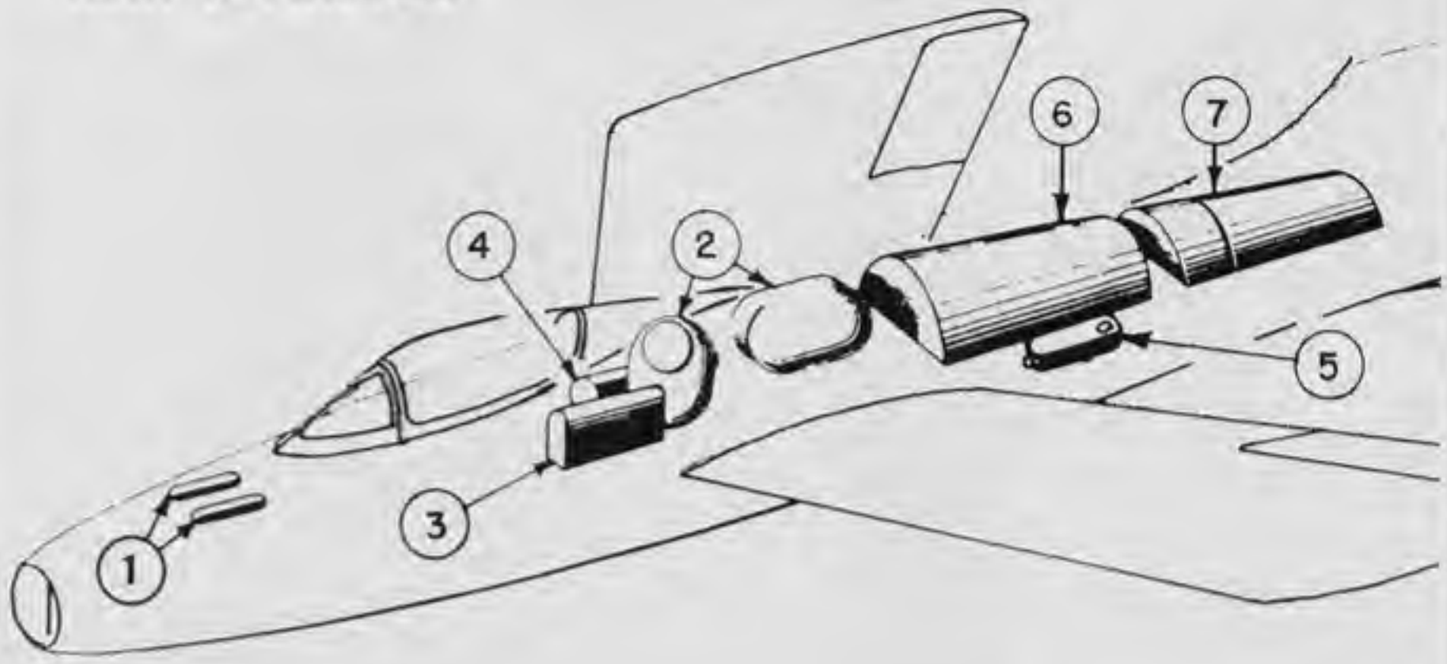
The XF-91 airplanes were composite-powered air vehicles that were optimized to use both a single turbojet engine and a rocket motor. The turbojet engine was fed its required allotments of air by way of a nose-mounted inlet system. The four-chambered rocket motor was arranged so that two of its chambers mounted above and two of its chambers mounted below the exhaust outlet orifice of the turbojet engine.

TURBOJET ENGINE:

Both XF-91 airplanes used the water-injected General Electric Model TG-190 series J47-GE-7, J47-GE-9 and J47-GE-17 turbojet engines. However, numerous other dash numbers of the J47 were tried during flight-test operations, including the -3, -11 and -21.

In service the J47 turbojet engine developed a maximum thrust rating of 6,900 lb with water injection; 6,100 lb without. It is of an axial-flow design and it featured the use a single turbine stage and 12 compressor stages. Its overall length was 154 in, its diameter is 35.5 in, and its power-to-weight ratio was about 2.4 lbs of thrust per lb of weight.

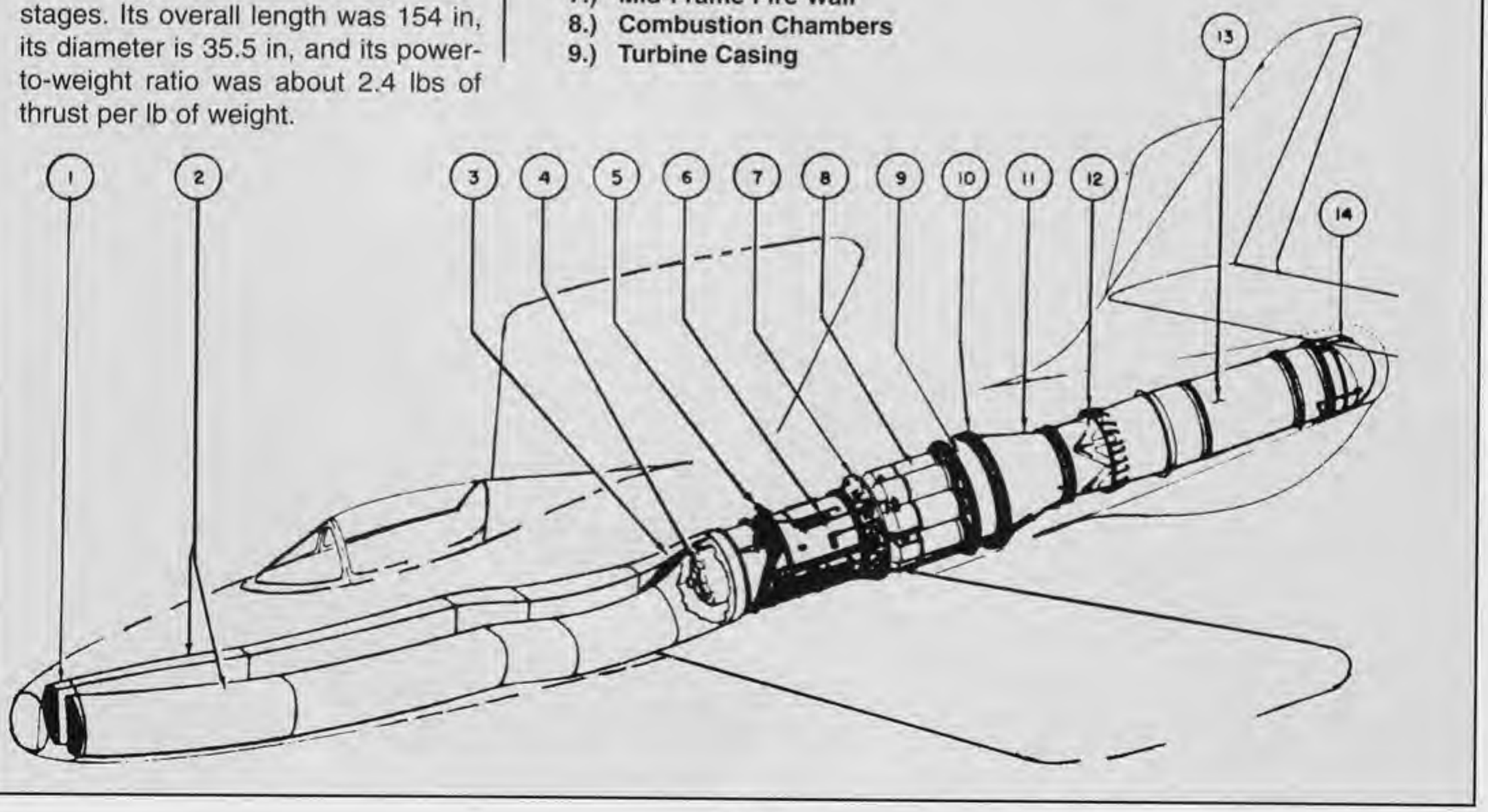
TANK CAPACITIES



1.)	Oxygen Cylinders	D-2
2.)	Liquid Oxygen	137 gal
3.)	Main Hydraulic Reservoir	4 gal
4.)	Emergency Hydraulic Res.	2.5 gal
5.)	Oil Tank	3 gal
6.)	Main Fuel Tank	231 gal
7.)	Water / Alcohol	141 gal

J47-GE TURBOJET ENGINE INSTALLATION

1.) Air Inlet Ducts
2.) Split Air Ducts
3.) Removable Pants Ducts
4.) Power Take Off
5.) J47 Engine
6.) Compressor Section
7.) Mid-Frame Fire Wall
8.) Combustion Chambers
9.) Turbine Casing
10.) Turbine
11.) Tail Cone
12.) Afterburner Section
13.) Tail Pipe
14.) Clam Shell Nozzle



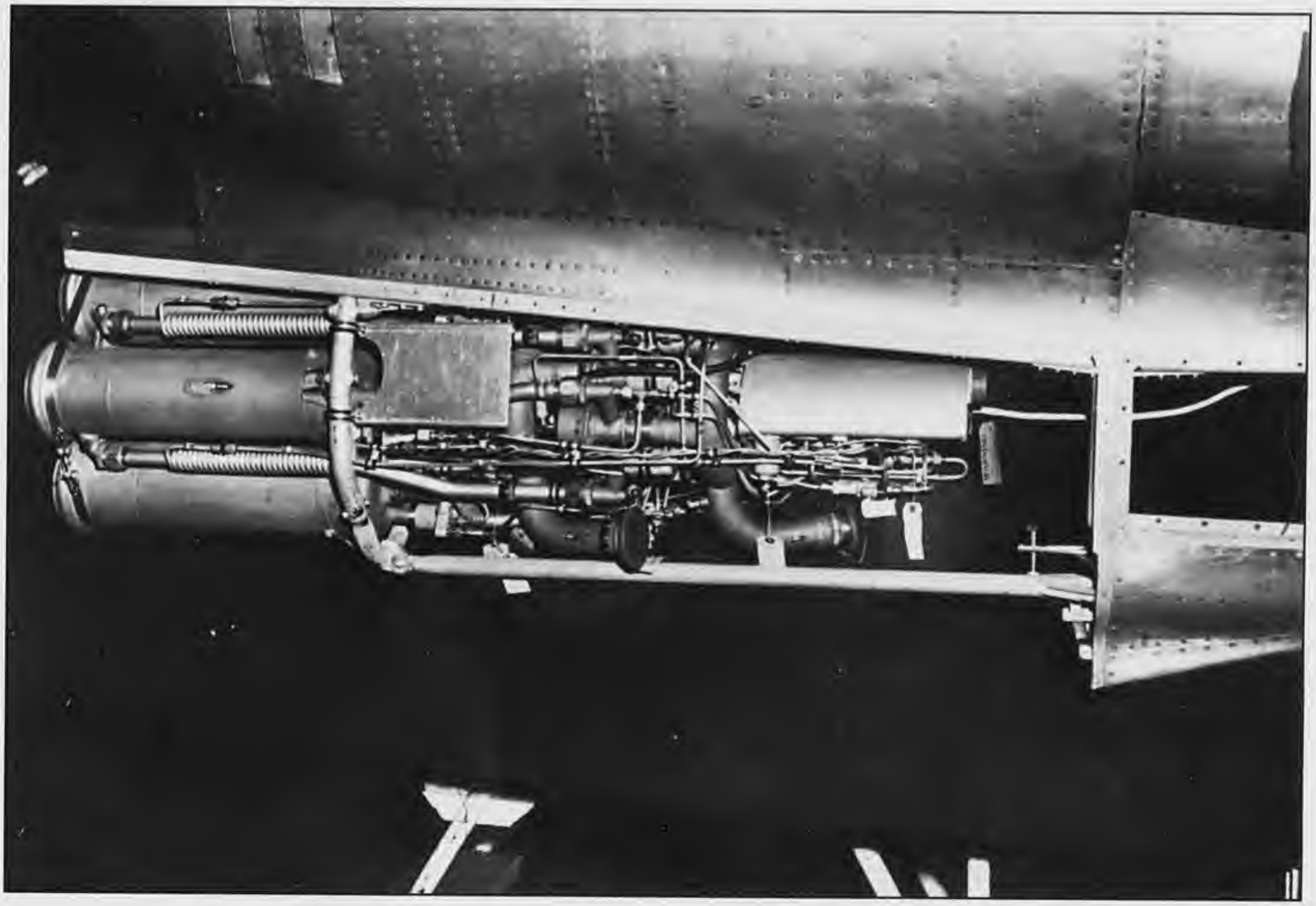
ROCKET MOTOR INSTALLATION

ROCKET MOTOR:

The four-chamber rocket motor was installed in the aft fuselage of the XF-91 directly above (two chambers) and below (two chambers) the turbo-jet engine exhaust nozzle. The propellants for the rocket motor were supplied from liquid oxygen tanks and water-alcohol tanks contained in the fuselage, and large three-celled external tanks mounted on wing pylons. A helium tank, located in the fuselage above the left wing root was used for helium storage under pressure. The helium was used to pressurize the liquid oxygen tank when starting the rocket motor and also to purge the system before and after rocket motor operation.

The Curtiss-Wright Model XLR27-CW-1 rocket motor was designed for operation between sea level and 70,000 feet altitude and was comprised of four pump-fed thrust chamber assemblies rated at 4,000 pounds thrust each. The basic rating of the rocket motor then was 16,000 pounds thrust for a duration of 90 seconds. The motor was provided with two sea level thrust chambers delivering 4,000 pounds thrust each, and two otherwise similar altitude-thrust chambers with nozzles designed for approximately 25,000 feet pressure altitude, rated at 4,450 pounds thrust each at that altitude. The sea level and altitude thrust chambers operated in pairs during takeoff and climb. For high-speed operation at 50,000 feet altitude, either one or both of the altitude thrust chambers were operated to produce 4,680 or 9,360 pounds thrust respectively. Propellants were commercially pure liquid oxygen (LOX) as the oxidizer and a mixture of 75 percent AN-A-18 (1) especially denatured ethyl alcohol and 25 percent water by weight as the fuel. An igniter comprised of an igniter housing, spark plug, and a pre-mixer nozzle provided ignition of the propellants. The water-alcohol (WALC) mixture fuel was used to re-generatively cool the thrust chamber nozzle jacket before being introduced into the thrust chamber through the injector. A film of fuel on the chamber wall cooled the combustion chamber. The motor incorporated a gas generator, utilizing the same propellants as the

Below, four XLR-11 rocket engines were installed in the lower rocket housing in-lieu of the XLR27-CW-1 rocket engines under development for the F-91 program. They were mounted and utilized to help the XF-91 explore its high-speed flight characteristics. (Republic)



UPPER XLR27-CW-1 ROCKET MOTOR INSTALLATION

At right, "Rocket Men"! The fueling crew pose next to the XLR-11 rocket motors installed in the lower fairing.

thrust chambers, which drove a two-stage pressure compounded impulse type turbine with radial inward flow. Provisions were made in the design of the rocket motor to obtain propellant tank pressurants, by vaporizing liquid oxygen in a heat exchanger and diverting WALC vapor from the gas generator, for internal and external tanks, respectively.

The XF-91 had two very large wing-mounted external fuel tanks on pylons. Each wing tank was divided into three separate sections and contained the fuel required for the rocket motor and turbojet engine during the climb from take-off until operating altitude was reached. A manually operated switch located in the cockpit released a mechanical lock on both wing tanks. Pneumatic cylinders, located within the pylons, jettisoned the tanks. Wing tank capacities were as follows: Forward section, 60 gal jet fuel; Center section, 264 gal WALC; Aft section, 218 gal LOX. (Note: WALC is a mixture of 75% alcohol and 25% water by weight. The mixture should have a specific gravity reading of .860 at 60 deg F. LOX is pure liquid oxygen.)

The rocket motor propellants contained in the fuselage tanks supplied the rocket motor for high-altitude operation. Two LOX tanks, located in the forward fuselage, were interconnected to form one tank. The aft fuselage section contained two WALC tanks and they were connected in a similar manner to form a second tank. The forward LOX tank held 127 gal while the aft WALC tank had 141 gal.

At left, test installation of the Curtiss XLR27-CW-1 rocket engine in the upper fuselage. Only the lower of two chambers have been installed. These engines were never test flown. (Republic via Cradle of Aviation Museum)

At left, as proposed in August 1949, along with a revised dorsal fin, this delta-shaped stabilizer leading edge was later incorporated on XF-91 number one. (Republic via Cradle of Aviation Museum) Below, originally, the XF-91 was to feature clamshell styled speed brakes, one on either side of the fuselage, as shown. A similar type speed brake arrangement was later used on the F-105 Thunderchief but this type was not used on the XF-91 airplanes. Instead, as used, the XF-91 airplanes employed a single, ventrally mounted speed brake on centerline. (Republic via Cradle of Aviation Museum)

XF-92 COMPETITOR

CLOSEST RIVAL

The Republic Aircraft Corporation's closest rival in the competition to produce an all-out performance interceptor pursuit airplane was Consolidated Vultee Aircraft (Convair). So close, in fact, it too was awarded a contract to produce not two but three prototypes designated XP-92 under Secret Project MX-813 (S/Ns 46-682/-684). It was to climb to 50,000 ft in four minutes, following takeoff rotation, and attain a top speed of 700 mph in level-attitude flight.

In its final configuration, the Convair XP-92 Dart was to be a tube-shaped air vehicle with relatively small delta-shaped wings and vertical tail with no horizontal stabilizers. The cockpit was to be housed within a sharp-pointed, cone-shaped facility of a smaller circumference than the fuselage, on centerline, just ahead of the main body. It was to be powered by a ducted ramjet engine with externally mounted liquid fuel rocket motors for takeoff and supersonic climb, and a single Westinghouse J30 turbojet engine for subsonic cruising power and landing. It was to be 38 ft, 4 in long, 17 ft, 3 in high with a wingspan of 31 ft, 3 in.

By the time Convair had built a full-scale engineering mockup of its proposed XP-92 airplane, the USAF had become leery of the aircraft's performance capabilities - especially since it was to try several untried concepts; specifically, delta-shaped flying surfaces and the unproven ducted ramjet/rocket motor propulsion system. Yet the USAF, working in concert with the NACA, held great interest in the evaluation of delta-shaped flying surfaces.

The result was the cancellation of the XP-92 interceptor program and the creation of the delta wing research program. Thus, in November 1946 XP-92s 46-683 and 46-684 were cancelled, and 46-682 would be built as the research airplane.

Above, lift off! The XF-92A takes off for the first time on 18 September 1948 from North Base at Muroc. Below, repainted white with red control surfaces, the XF-92A is seen in flight in 1950. (AFFTC/HO)

As a dedicated research aircraft, to distinguish this one-of-a-kind experimental airplane from the original XP-92 program, the airplane was re-designated XP-92A. It was also known as Convair Model 7-002 (nicknamed Seven-Balls-Two) because, as it happened, 7-002 was Convair's accounting departments work order number for the program when initiated.

As an aside, with Convair out of the running to produce a competing aircraft to challenge the XF-91, RAC management was of course more than thrilled. Moreover, at the time and subsequent, RAC did not have any other competitor to worry about as well. It was simply clear sailing for RAC and its XF-91 program.

To create the XP-92A, Convair managed to incorporate the nose landing gear from a Bell P-63 King Cobra, the main landing gear from a North American FJ-1 Fury, an ejection seat and cockpit from its own XP-81 "Silver Bullet", and various other hand-me-downs.

On 18 September 1948, with Convair's Ellis D. "Sam" Shannon at the controls, the XF-92A (as it had been re-designated on 11 June 1948 when the "P" for Pursuit prefix had been changed to "F" for Fighter) rose off the dry lakebed at Edwards AFB and made its first flight. This event marked the first flight in America of a delta-winged aircraft.

During its flight-test, the XF-92A was flown a total of 118 times by Convair, USAF and NACA pilots. Its top speed was reached when Chuck Yeager flipped it on its back and pulled four Gs in a full straight-down 90 deg split-S dive to register Mach number 1.1 before his pull out.

The one-off XF-92A is 42 ft, 5 in long, 17 ft, 8 in high, and it spans 31 ft, 3 in (compare with the original XP-92). In its final configuration it was powered by a single afterburning Allison-built J33-A-29 turbojet engine that delivered 8,200 lb maximum thrust.

It has been on display at the U.S. Air Force Museum at Wright-Patterson AFB, Dayton, Ohio, since 1969.

With the knowledge and experience it learned from its XP-92 and XF-92A programs, Convair (later the Convair Division of the General Dynamics Corporation) went on to produce a number of successful, and not so successful, delta-winged aircraft. Namely: the B-58 Hustler, the worlds first double-sonic bomber; F-102 Delta Dagger, the world's first all-missile and all-rocket armed interceptor capable of supersonic speed; F-106 Delta Dart, still regarded to be the best interceptor ever fielded by the USAF; YF-7A (formerly YF2Y-1) Sea Dart, the worlds first sea-based interceptor; and the XFV-1 Pogo, the first VTOL aircraft to successfully transition from vertical takeoff, to horizontal flight, to vertical landing.

CONCLUSION

On the sixth anniversary of XF-91 number one's first flight - 9 May 1955 it arrived via 18-wheeler at the U.S. Air Force Museum, Dayton, Ohio, where it remains on display today. The number two XF-91 was used as a crash-crew training simulator at Edwards and was later scrapped.

Two views of the XF-92A as it appeared in the John Wayne movie Jet Pilot as a fictional MiG-23. (AFFTC/HO)

LINDBERG 1/48 SCALE XF-91 KIT

Large raised rivets, raised decal locations, no cockpit details, crude pilot figure, bogus rocket armament, that's what modeling in the early '50s was all about. Especially if the kit was made by Lindberg. The F-91 box top above is believed to be the first Thundercepter box art. At right is a model built stock from the box in the late 1950s without landing gear or bogus rocket armament.

Below is Rodney Williams' award winning XF-91 Thundercepter model circa 1990. It was an incredible model and demonstrates what can be done with a terrible kit as long as the kit's outline and dimensions are reasonably accurate.

The landing gear was made from brass and plastic with "O" rings for tires. The landing gear bays were fully detailed as was the speed brake well. The kit canopy was modified into a vacuform mold and a new canopy was created. The canopy was posed in the open position with all its intricate hardware. An F-84F cockpit tub was reworked and installed into the otherwise empty kits cockpit area. The afterburner exhaust area

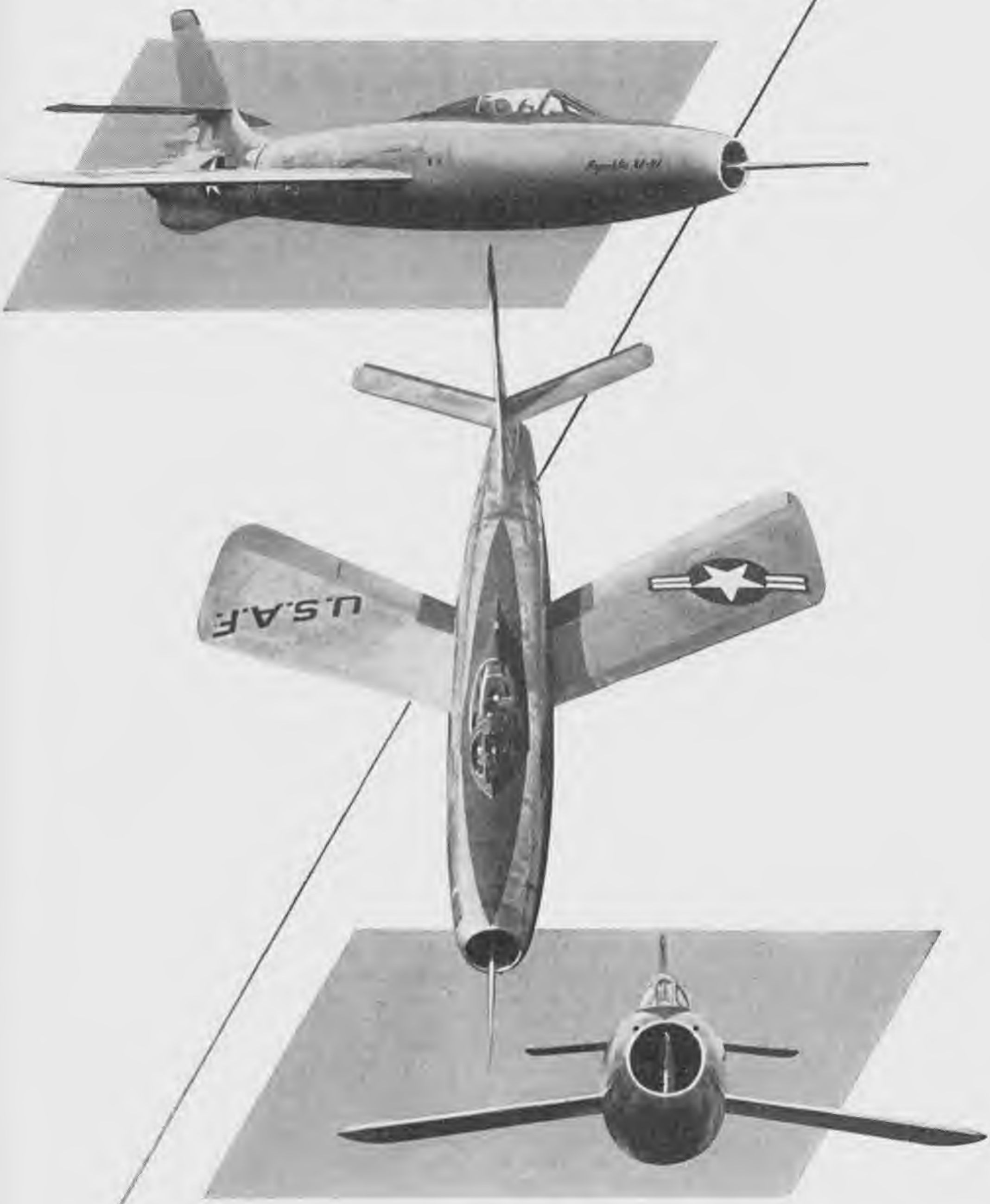
received a complete overhaul as well as the kit's intake. The kit's drop tanks were shortened to the proper length and new fins were manufactured. The kit's surface was sanded clean and new panel lines were scribed before the professional finish was applied. **(R. Williams via Wayne Morris)**

PROJECT X 1/72 SCALE VACUFORM XF-91 KIT

These kits are always good and this one is filled with options. Vacuform parts are included for the standard nose and the radar nose, as well as for the standard and butterfly tail. Both style drop tanks are offered too. The kit comes with decals and white metal parts for the landing gear, ejection seat, nose probes, rocket and jet engine exhausts, and control stick.

Although the parts are provided for the butterfly tail, major kit surgery and fuselage puttying would be required, so I opted for the radar nose version.

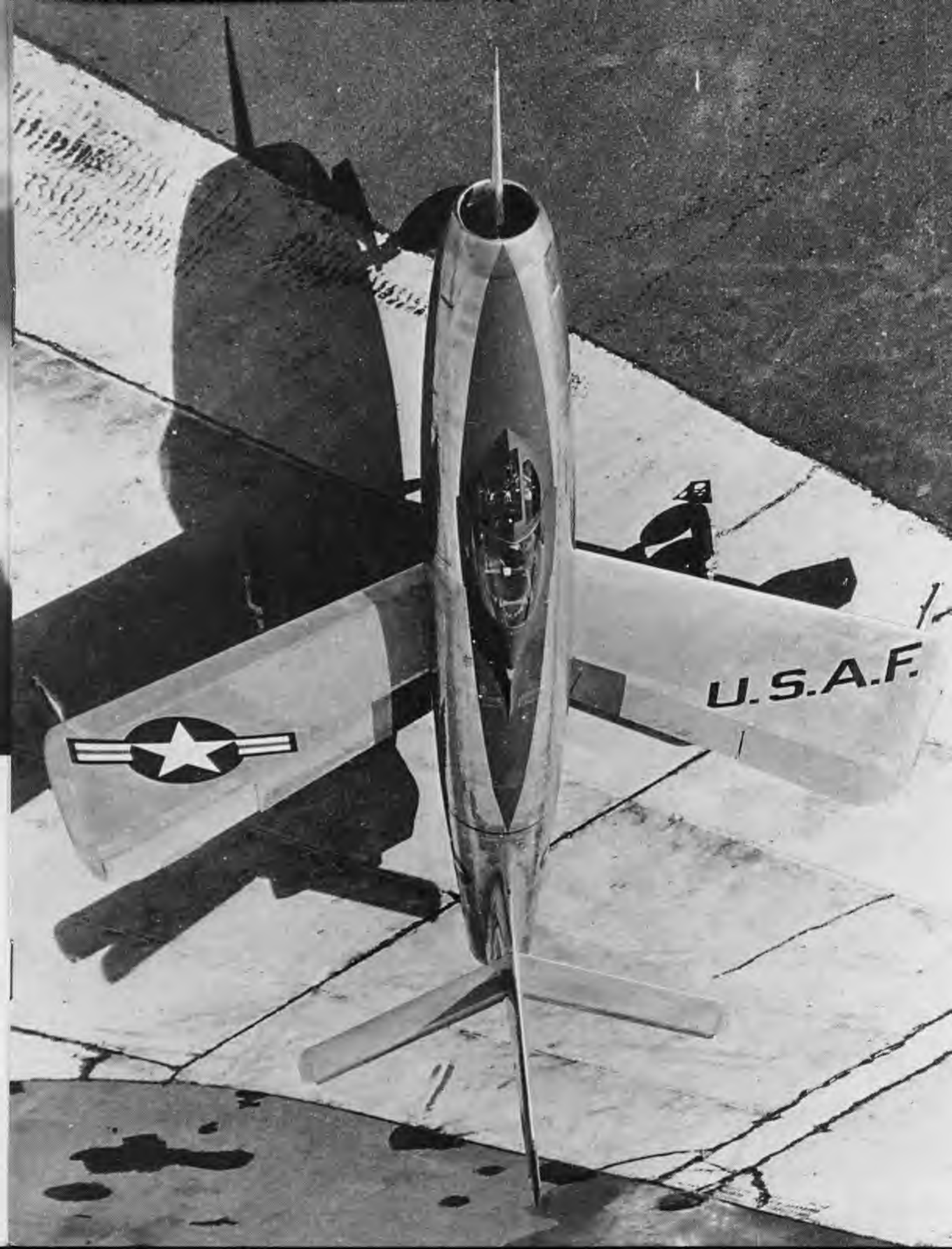
THIS IS THE XF-91



REPUBLIC AVIATION

Farmingdale, Long Island, N.Y.

Makers of the Mighty Thunderbolt · Thunderjet · XR-12 · XF-91


U.S.A.F.